The California Fire Economics Simulator Version 2 User's Guide

Developed in cooperation with the
California Department of Forestry and Fire Protection

by

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Foreword

CFES2 is a very different program than CFES-IAM (California Fire Economics Simulator – Initial Attack Module) version 1.x (Fried and Gilless 1988b), with a more realistic and detailed characterization of initial attack, real-time display of the simulation process, an improved user interface, and the capacity to export both input data and simulation outputs to relational databases.

Simulation modeling has come a long way during the past decade, and researchers increasingly recognize that models cannot be transferred to users without practical consideration of the associated database management problems. Unfortunately, there are no non-proprietary relational data structure standards, and recent history has seen considerable instability in the market for database platforms (changes in vendors, platform discontinuance, etc.). We therefore decided against relying on any particular third-party vendor for CFES2's database management needs, and instead developed a customized, memory-resident, binary database management system that users are expected to supplement with a relational database of their choosing.

A related design decision was not to have CFES2 produce printed reports of simulation outputs. Given the difficulty and drawbacks of developing a standard report format, we opted to allow for all input data and simulation output to be written to comma-delimited ASCII files that can be imported into relational databases for post-simulation report preparation, archiving, aggregation, or for performing statistical, operational or economic analyses.

Within limits, we have tried to design enough flexibility into the CFES2 data entry protocols to allow data elements to be entered in any order convenient to the user. The cost of this flexibility is that the user must sometimes take greater responsibility for the integrity and accuracy of the data entered. While it would have been technically feasible to design CFES2 to make it possible to import all of its input data from a relational database of the user's choice, it would be difficult to ensure the validity of data thus imported. CFES2 performs many validity checks on data as it is entered, and many more consistency checks before executing a simulation.

CFES2 contains provisions for the adjustment of numerous simulation parameters; however, the default values should be suitable for most users. Nonetheless, it will take most users several hours to learn the basics of simulator operation, and considerably more time to gather and enter the input data. Most users will find it helpful to load the software on their computer and to follow along using the Santa Clara Ranger Unit demonstration data set as they read through this User's Guide.

CFES2 can be run in any version of DOS (3.0 or greater) or in a full-screen DOS window under any of the DOS-compatible Intel X86-based operating systems currently available, including Microsoft® Windows™ 3.x, Windows 95™, Windows NT™, OS/2™, and DESQview™. CFES2 is not a Windows program, in part because work on it started in 1987. Avoiding the Windows interface allowed for more rapid program development, and resulted in a smaller, faster program. Converting the program would be a major undertaking, and is not anticipated at this time.

To minimize confusion between CFES-IAM version 1.x and CFES2, we have designated the first release of CFES2 as version 2.00. We hope that most of the program's bugs have been detected. In the event that problems do arise, please report them to the authors. We also welcome suggestions on how the program can be improved.

Acknowledgments

We are indebted to many remarkable people who contributed to the development of CFES2. We thank the California Department of Forestry and Fire Protection (CDF) for funding, and the CDF's Sacramento staff, past and present, particularly Glen Lee, Don Perkins, Jim Spero, Wayne Mitchell, and Chris Difani for their intellectual and logistical support. We also thank the hundreds of CDF and USFS firefighters who participated in the production rate survey and validation exercise, and all of the CFES coordinators -- especially Dave Wachtel for his work on the demonstration data set for the Santa Clara Ranger Unit.

At the University of California, Berkeley, Professors Lawrence Davis and Robert Martin, students David Chalfant, Tian-Zhong Zhao, Sean Egan, Russell Henly, and Kinshuk Govil, and photographer Jerry Morse all played important roles at some juncture during CFES2's 10-year gestation.

The senior author thanks his father, Professor Emeritus Burton D. Fried, for assistance in the theoretical development of the containment algorithm which underlies CFES2, and his wife, Kathleen Tully, for her patience, understanding, and love during what has, at times, been an all-consuming effort.

Typographic Conventions

This User's Guide has been designed with typographic conventions shown in Table 1 to help the user distinguish among different kinds of text: descriptive, display text, user entered or editable text, etc.

Table 1. Typographic conventions.

Text type	Font(s)
Descriptive text	Bookman Antiqua
Terminology	*Bookman Antiqua italics*
Menu or menu choice	***Bookman Antiqua italics bold***
Keys (e.g. <F1>, <Esc>, <Ctrl><Enter>)	**Courier Bold**
Display text	Typewriter
Text entered or editable by user	**Typewriter bold**
Text entered or editable by user in current (active) field	**Typewriter bold dot-underlined**
Selected menu choice	**Typewriter bold underlined**
Help prompt	*Typewriter italic*

I. Introduction

The California Fire Economics Simulator version 2 (CFES2) is a computer program for stochastic simulation analysis of a wildland fire protection organization's initial attack system. CFES2 was developed by the University of California under a contract with the California Department of Forestry and Fire Protection (CDF). It is the successor to CFES-IAM version 1.x, a deterministic simulation model used by the CDF since the early 1990s (Fried and Gilless 1988b). CFES-IAM was based upon the Initial Action Assessment (IAA) module of the U.S. Forest Service's National Fire Management Analysis System (NFMAS), but did not incorporate that model's use of the "cost-plus-net-value change" criterion (Gorte and Gorte 1979).

The new features added in CFES2 include: stochastic treatment of fire occurrence, fire behavior, and fireline production; real-time display of the simulation process; an improved user interface; and the capacity to export both input data and simulation outputs to relational databases.

CFES2 can be used to play a variety of "what-if" games involving hypothetical changes to fuels, climate, firefighting strategies and tactics, dispatch criteria, fireline productivity, detection time, availability of firefighting resources, fire prevention, deployment rules, accessibility, and staffing schedules. Full utilization of CFES2 in this fashion requires post-processing simulation outputs using a relational database. CFES2 simulation outputs include or can be used to calculate:

- Expected percentage of fires that would be "contained" within user-specified size and time limits
- Expected area burned by "contained" fires
- Distribution of contained fires by fire size and dispatch level
- Expected firefighting costs for contained fires
- Expected numbers of dispatches (missions) for individual firefighting resources
- Descriptive statistics for the (simulated) distributions of any of the aforementioned criteria, e.g., variances or 90th percentile values

It should also be noted that CFES2 was not designed to support tactical decision-making during initial attack. It can be used most effectively in support of strategic planning. Finally, it should be kept in mind that effective use of CFES2 requires extensive consultation with local fire managers to make appropriate judgments about a variety of simulation parameters – as with all models, the results of CFES2 simulations are only as good as the data upon which they are based.

This User's Guide documents CFES2's input data, simulation outputs, critical assumptions, and operation. It also contains some example analyses. It is assumed throughout that the reader has access to the CFES2 software and demonstration data set (SCUDEMO.CF2), copies of which can be obtained from the authors.

This User's Guide necessarily contains a large number of technical terms and acronyms. For the reader's benefit, these are listed and defined in Appendix V.

II. Simulation Models

Simulation models like CFES2 are designed to capture the essence of a "system" (in this case, of initial attack on wildfires) in a mathematical model that mimics the functioning of the system. If sufficiently realistic, simulation models can help identify solutions to critical problems, and robust models may even be useful in addressing problems not anticipated when they were developed.

One of the under-appreciated aspects of simulation models is their ability to enhance our understanding of a system through the process of quantifying the relationships within the system being modeled. This quantification can be *deterministic* or *stochastic*. With a deterministic model like CFES-IAM, a given set of inputs will always produce the same results. A stochastic model like CFES2 can (and usually will) yield different results every time it is run, even when the same inputs are used. This is because one or more fundamental relationships in the system have been represented in the model with a random (stochastic) component. Stochastic models usually require more complex inputs and more processing time, but they can also provide deeper insights into a system, especially for one in which uncertainty and risk are important.

Simulation can be very useful for assessing the impacts of changes in a wildland fire protection system such as redeployment of firefighting resources or more active vegetation management. Simulation can be automated so as to produce a wide variety of possible scenarios and associated outcomes, without regard to current practice, in the hope that a near optimal solution will be identified. Alternatively, it can begin from a "base case" that represents current practice and conditions, and be guided by an analyst familiar with the system and with the range of scenarios it might be worthwhile to consider.

Given the time and expense required to build and run a simulator like CFES2, some will ask, "Why bother?" One answer is that the complexity of wildland fire management is such that good decisions are difficult to make. Another is that bad fire management decisions can have catastrophic consequences. While an experienced fire manager may recognize and understand some of the simpler qualitative relationships in the system (e.g., additional bulldozers, well-distributed, should reduce the frequency of escapes and area burned); predicting the quantitative impact of changes to the system, especially those which involve several dimensions, is far more difficult (e.g., vegetation management changes fire behavior, firefighting tactics, and line-building rates). Complex interactions can be explored in-depth using simulation, and intuitive expectations with respect to simpler relationships can be rigorously tested and refined.

In any case, simulation offers a safer means of experimenting with a system than implementing changes on a trial basis. No prudent fire manager would decommission a fire engine for 10 years to determine whether or not more houses would burn as a result, and most would be reluctant to redeploy an engine without compelling evidence that this would enhance fire protection. In short, issues of irreversibility and public safety restrict or preclude some kinds of experiments in fire management. It is in precisely such situations that a simulation approach can lead to better management decisions.

Simulation modeling is both a science and an art because of the inescapable trade-off between model realism and data requirements. Relatively simple models such as CFES-IAM can help us understand elements of the wildland fire protection system, but may not be of much help in answering some of the more pressing questions we want to ask about the system. On the other hand, extremely complex models, capturing every nuance and possible permutation of the system, can be burdensome to quantify and difficult to interpret. These limitations are particularly important when working with models that make linkages to spatially-referenced data like GIS coverages. It is generally agreed that the best models are those which capture the elements of a system of critical concern to the clients needing the model, without being needlessly complex. CFES2's design is the result of a conscious effort to balance complexity with realism, and to allow the user to make a number of decisions concerning the appropriate level of complexity. Simulation parameters for everything from strategy and tactics to resource staffing schedules can be adjusted to enhance model realism, or to force any of the stochastic components of the system to operate in a deterministic fashion (e.g., it is possible to "hard-wire" fireline production rates).

In developing CFES2, we tried to tailor the model to the needs of the CDF fire managers we consulted with at every stage. We hope that these managers (and their counterparts in other agencies) will find the end product of our collective effort to be useful.

III. System Overview

This chapter outlines our conceptualization of initial attack as a system. In this context, it should be noted that while CFES2 simulations provide a very realistic portrayal of initial attack, exact representation of the real world has so far eluded every simulation model ever constructed, and responsibility for considering factors not directly represented in CFES2 (e.g., emergency medical response or mutual aid programs) falls squarely on the shoulders of the fire planners who will use CFES2. It is best to think of CFES2 as a tool that can provide useful guidance to fire planners, complementing rather than replacing their judgement and experience.

The technical terms and acronyms used in this section are listed and defined in Appendix V.

Geographic Representation

Ranger Units

For the CDF, *Ranger Units* constitute the administrative level at which fire planning tools like CFES-IAM or CFES2 are utilized. Their size is variable, but they usually encompass one or more counties. The example data set distributed with CFES2 comes from the CDF's Santa Clara Ranger Unit (Figure 1).

Fire planners from other agencies will probably find it useful to interpret the term "Ranger Unit" in this User's Guide as referring to the administrative level at which planning will be conducted for their initial attack system, keeping in mind that a Ranger Unit is also the level at which CFES2 models fire occurrence, i.e., it is the level at which the frequency and spatial distribution of fires is statistically characterized and simulated.

FMAZs

CFES2 requires Ranger Units to be stratified into one or more *Fire Management Analysis Zones (FMAZs).* The CDF's Santa Clara Ranger Unit shown in Figure 1 has been stratified into six FMAZs – SCUAL, SCUAM, SCUBL, SCUBM, SCUGM, and SCUFM.

FMAZs should be relatively homogenous with respect to fuels, slope, and any other characteristics such as values at risk that have a major impact on the definition of success for initial attack. A geographic information system (GIS) is helpful, but not essential, in delineating and characterizing FMAZs. By convention, the fourth character of a FMAZ designator represents the dominant NFDRS fuel model, and the fifth letter, the relative human population density (L=Low, M=Medium, H=High).

CFES2 input data defined at the FMAZ level includes the percentage of a Ranger Unit's *fire load* (i.e., ignitions) occurring within the FMAZ; the *simulation size* and *time limits* beyond which fires are declared to be *ESL (Exceeded Simulation Limits) fires;* the weather stations, fuel models, and slope classes used to characterize fire *Rate of Spread (ROS)* and *Fire Dispatch Level (FDL);* size classes for tabulating the results of simulations; backup and structure protection requiremen ts for firefighting resources; and per acre suppression costs.

RFLs

The spatial distribution of the fire load in an FMAZ is characterized using *Representative Fire Locations (RFLs).* These should be chosen to reflect historical or anticipated variation within the FMAZ in fire type, location, resources dispatched, resistance to control, and values at risk. Maps of past fire starts are useful in choosing RFLs. With large or discontinuous FMAZs, it is important to choose RFLs in a manner that reflects differenc es in the firefighting resources that would ordinarily respond to otherwise similar fires.

CFES2 input data defined at the RFL level include dispatch policies, firefighting tactics, and resource response times.

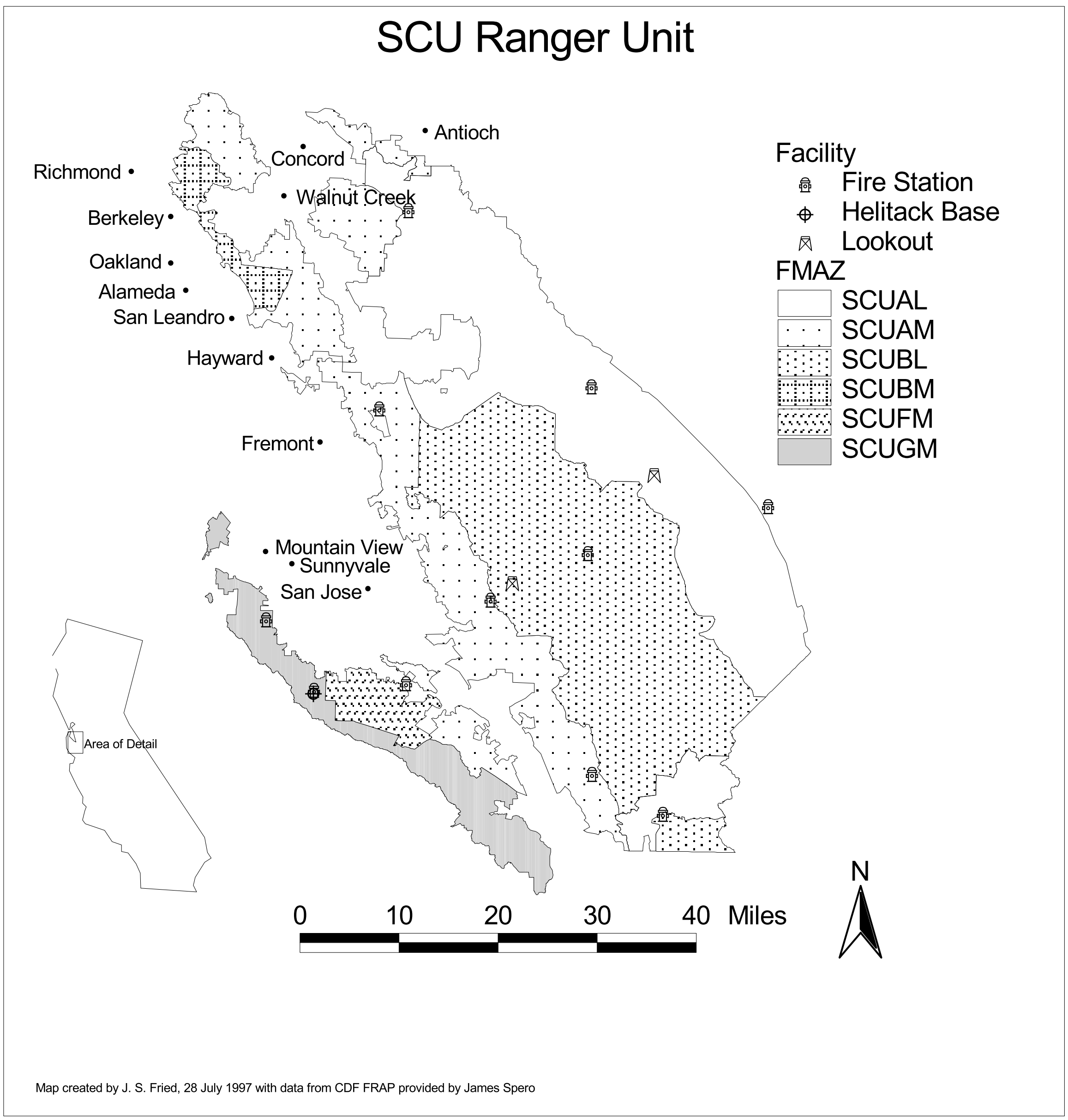


Figure 1. FMAZs and stations for firefight ing resources on the Santa Clara (SCU) Ranger Unit.

SIMULATION PROCESS

CFES2 can be thought of as a collection of several modules, each designed to represent some aspect of an initial attack system. These modules include:

- Occurrence
- Behavior
- Dispatch
- Fireline Production Rate
- Containment

Some modules, such as Containment and (parts of) Dispatch, are deterministic in that while they utilize data generated by stochastic processes, a given set of input data always results in the same outcome. Occurrence, Behavi or, and Fireline Production Rate, on the other hand, are based upon stochastic representations of those processes.

Figure 2 shows how these modules interact with one another. The CFES2 program simulates initial attack one a day at a time, progressively mo ving through the calendar year. For each day, the Occurrence module determines if any (simulated) fires will take place. If no fires will "occur", CFES2 advances the *simulation clock* to the next day. If one or more fires will occur, the Occurrence module d etermines how many, and the time of day at which they will start. The Behavior module then determines a 2PM ROS *and Burning Index (BI)* for the day, which is adjusted to reflect the time of day at which simulated events occur.

Simulation of fires then takes place progressively through the day, with the simulation clock advancing from one event in the simulation process to another. As each fire starts, the Dispatch module determines which firefighting resources should be dispatched to the fire, keeping track of the resources that have already been committed to other fires. As dispatched resources arrive at a fire, the Fireline Production Rate module assigns them a production rate, and the Containment module evaluates the cumulative interaction of fire behavior and containment efforts. For fires that would be contained within simulation size and time limits, a final fire size is calculated, along with total mission and per acre suppression costs. When all of the day's fires have been contained or declared to be ESL fires, the simulation process advances to the next day, and is repeated. At the end of a year of simulated fire activity, the simulation clock is reset to January 1 st, and the process is repeated for another year, until the desired number of years of f ire activity have been simulated. Examining the results of many (e.g., 100) years of simulated fire activity allows for statistical characterization of the natural variation in fire occurrence and the effectiveness of initial attack efforts under different stationing and dispatch polices, conditions of resource availability, fuel management programs, etc.

Each of the simulation modules noted above are described in greater detail below.

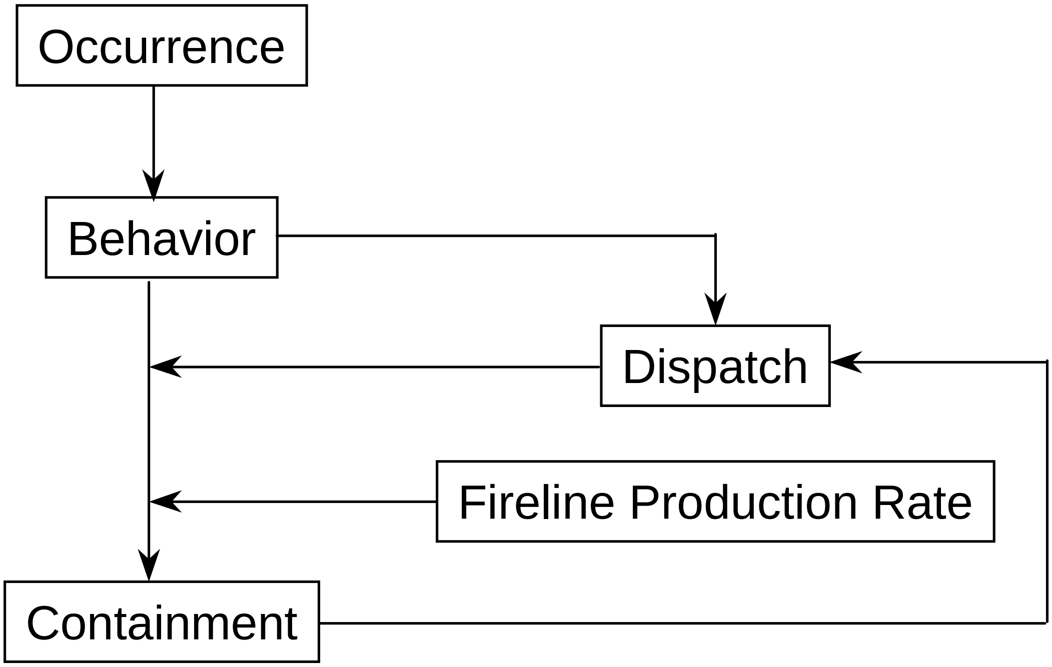


Figure 2. CFES2 modules and their interactions.

Occurrence

As a CFES simulation progresses through the year, the Occurrence module employs a three-stage stochastic selection process to determine how many fires to simulate on a given day. The parameters of these distributions must be estimated using historical fire activity data (Fried and Gilless 1988a). First, a Bernoulli distribution (*Fire Day*) is sampled to determine whether or not any fires occur on a given day. If so, then a geometric distribution (*Multiplicity*) is sampled to determine how many fires occur (Figure 3). Finally, a beta distribution (*Time of Day*) is sampled to assign a starting time to each fire (Figure 4). The simulated fires for a given day are randomly assigned to RFLs in accordance with the proportion of the Ranger Unit's fire load associated with each. The parameters of the Fire Day, Time of Day, and Multiplicity distributions are specified separately for user-defined *low, transition* and *high fire seasons*. The Occurrence module is complex, but not more complex than necessary to realistically capture the problems caused by more than one fire occurring on the same day, and it allows for a straightforward treatment of diurnal variation in fire behavior.

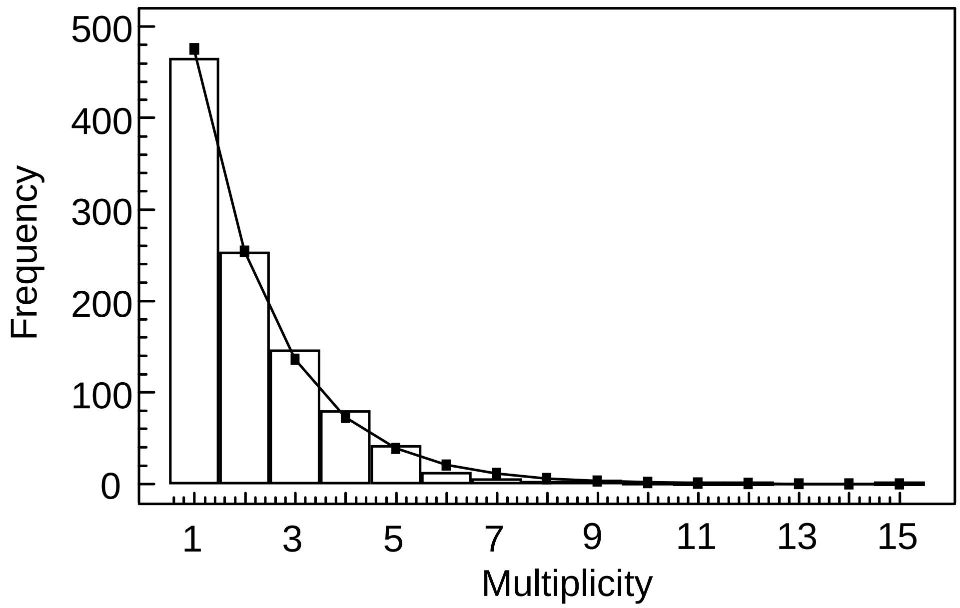


Figure 3. Fitted distributions for high fire season multiplicity (number of fires on a day), used in the CFES2 Occurrence module for the Santa Clara Ranger Unit.

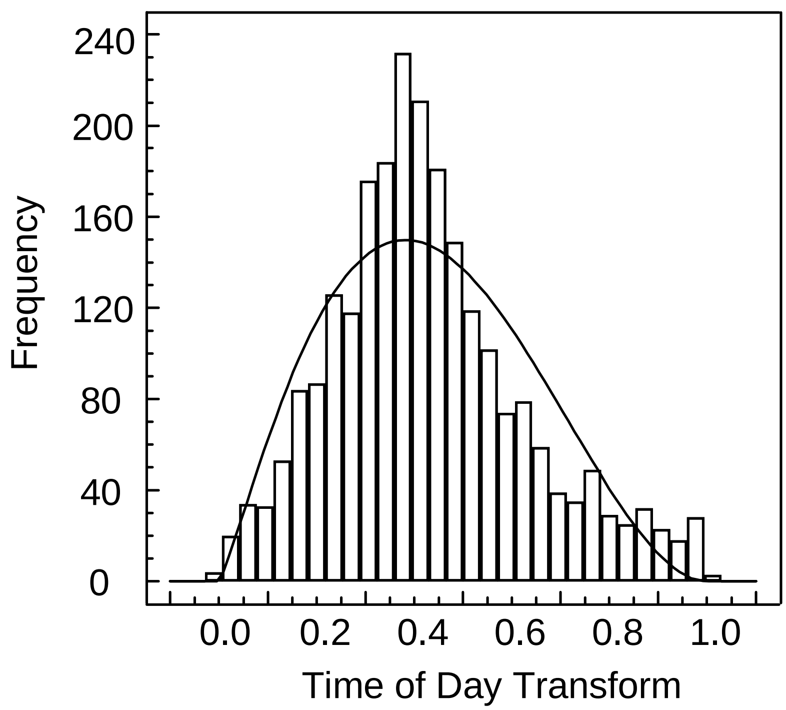


Figure 4. Fitted distributions for Time of Day used in the CFES2 Occurrence module for the Santa Clara Ranger Unit. The Time of Day distribution, defined on the interval 0 -1, is scaled to clock times of 5AM to 5AM.

Behavior

The Behavior module employs a coordinated fire behavior modeling process to ensure consistency in the behavior of fires that occur on the same day (Gilless and Fried 2000a).

For each FMAZ, one *behavior link* is used to determine a fire's FDL and one to determine its ROS – a behavior link being defined by a weather station, a fuel model, a slope class, a climate class, and a type of herbaceous vegetation. The FDL and ROS behavior links might be the same for a given FMAZ if FDL is based upon ROS. However, many CDF Ranger Units currently base FDL on BI, so CFES2 was designed to allow for flexibility in this regard. Whatever criterion is used for setting FDL, the breakpoints between low and medium and between medium and high FDL must be specified for each FMAZ. These breakpoints may reflect either current or projected practice, depending on the kind of scenario being simulated.

Behavior links are references to a set of season-specific parameters that define a distribution that is sampled to determine fire behavior at 2PM on days when simulated fires occur. A *compound distribution* is used to capture the bi-modal shape of ROS and BI distributions (Figure 5), since they have one peak associated with low BI or slow ROS fires, and another associated with more intense or faster moving fires. The left side of a compound ROS (or BI) distribution is therefore described by: (1) the probability of 2PM fire behavior for this behavior link being drawn from this part of the distribution; and (2) a constant (mean) ROS (or BI) value used to characterize the behavior of such fires. The right side of a compound ROS or BI distribution is described by the two parameters of a beta distribution, the minimum and maximum values of the behavior parameter, and a length-to-width ratio to use in simulating the elliptical growth of a fire. Data used to estimate the parameters of these compound distributions can be derived from historical 2 PM weather observations using FBDMOD (CDF 1992), a computer program that incorporates both the FIRDAT (Main et al. 1990) and BEHAVE (Burgan and Rothermal 1984, Andrews 1986, Andrews and Chase 1989) fire behavior models.

Dirurnal adjustment coefficients, corresponding to the hours of the day, are used to adjust 2PM ROS (or BI) values for each fire. Data used to estimate these adjustment coefficients can be derived from historical hourly weather observations using HISTROS (CDF 1991), a PC version of BEHAVE.

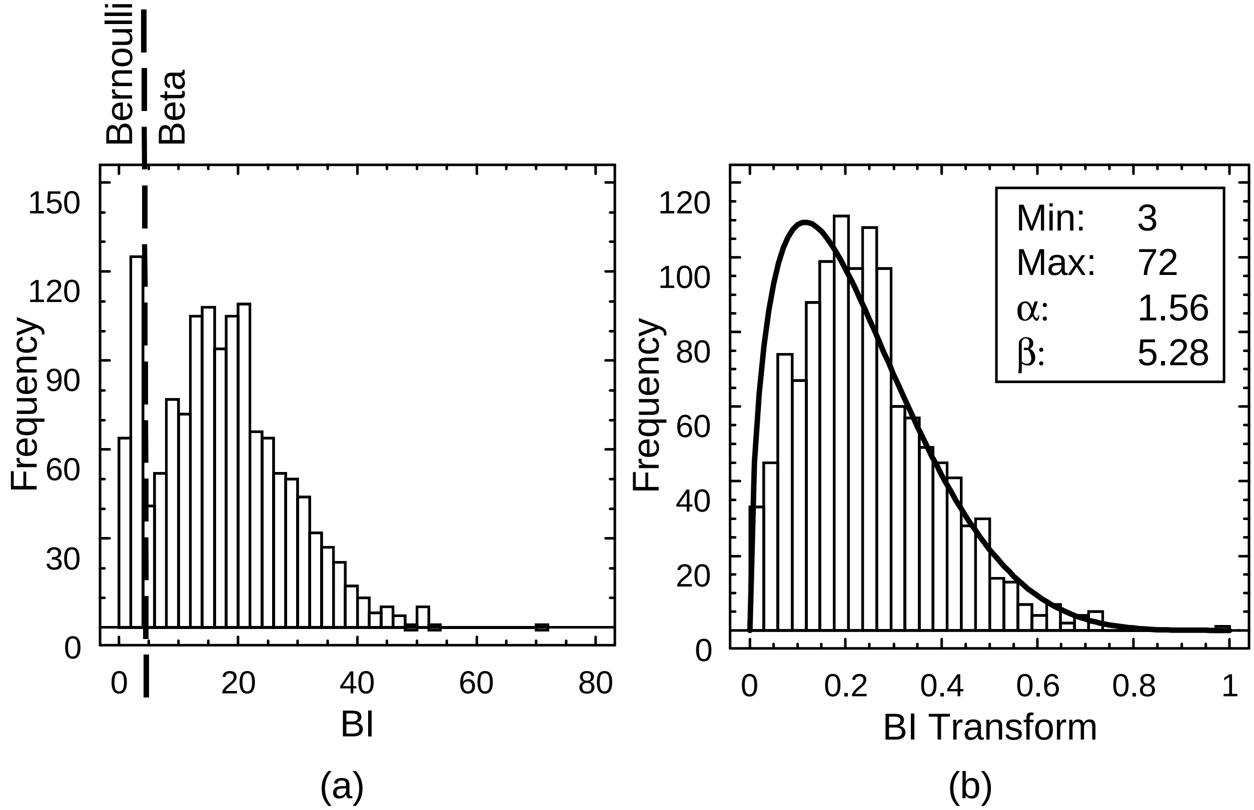


Figure 5. BI calculated using 10 years of data from the Arroyo Seco weather station, fuel model A3, slope class 2, high fire season: (a) Frequency histogram, with dashed vertical line defining ranges modeled with Bernoulli (left) and beta (right) distributions; (b) Beta range frequency histogram and fitted distribution .

Dispatch

The Dispatch module identifies which firefighting resources to dispatch to a fire by first comparing time-of-day adjusted ROS (or BI) values generated by the Behavior module with the FDL breakpoints for the FMAZ in which the fire is located to determine a FDL for the fire. It then identifies the resources available for dispatch to the fire that most completely satisfy the dispatch requirements for that fire.

Fireline Production Rate

The Fireline Production Rate module (Fried and Gilless 1989, Gilless and Fried 2000b) was designed to utilize the results of a statewide, expert opinion survey of engine captains, bulldozer operators and handcrew bosses. The survey was conducted in the field at sites chosen to represent different firefighting control conditions. Participants provided best case, worst case, and most likely estimates of how long it would take their crew or equipment to build a given length of fireline under specified conditions. Site- and equipment-specific beta distributions for the time to complete a fixed length of line were derived from these estimates. The results of the survey were published for more than 200 different *control conditions* in Lee et al. (1991). In this publication, each control condition is described, and illustrated with wide angle and close-up photos of a typical site, and fireline production rates are illustrated by a plot of the fitted beta distribution for each resource type (Figure 6). Best- and worst-case time estimates, and the parameters of the beta distribution fitting these estimates are given, along with estimates of the drop-off in fireline production rates that can be anticipated when crews get tired or engines exhaust their supplies of water.

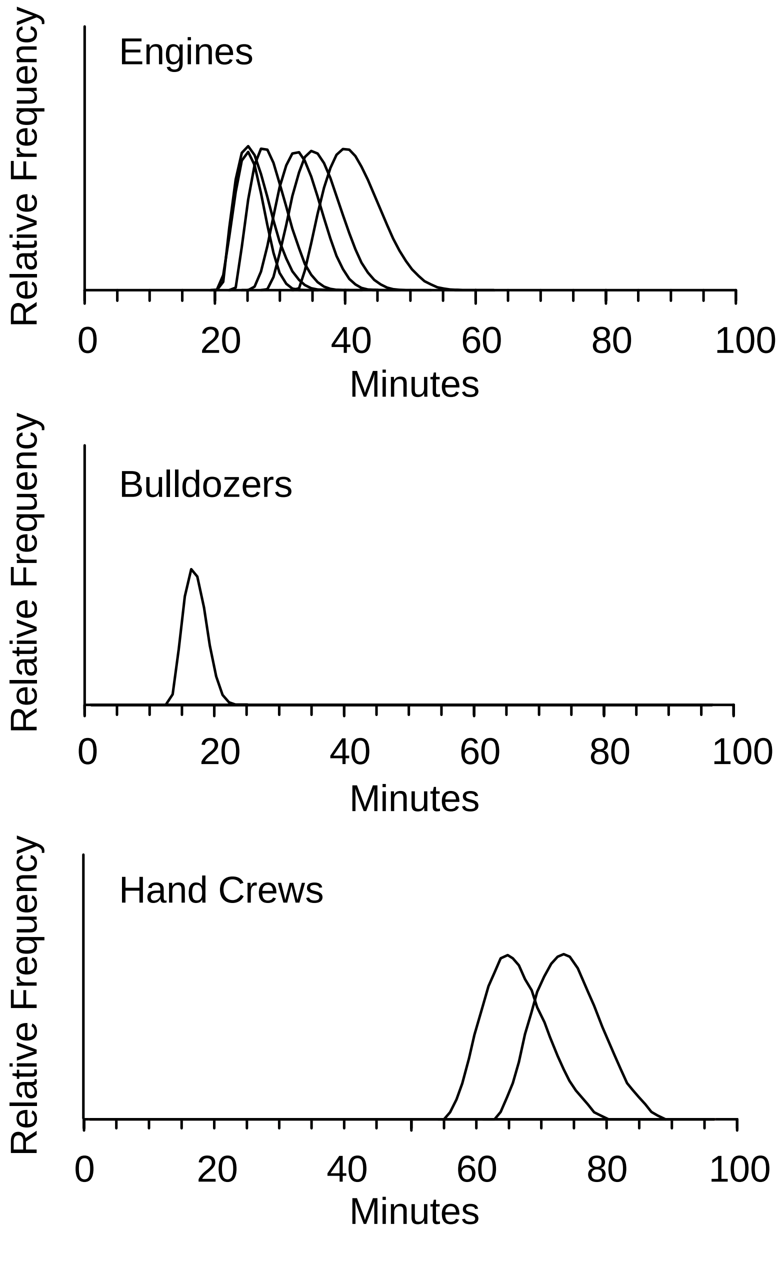


Figure 6. Production rate distributions for the time (in minutes) required to build a given length of fireline in a grass fuel control condition on the Santa Clara Ranger Unit.

Containment

Initial attack simulators like CFES-IAM and the USFS' IAA assume that fires spread in the form of an ellipse, and that line-building efforts have no impact on the spread of the fire until it has been contained. The elliptical assumption has been borne out in several studies of fire shape, and the eccentricity of the ellipse, or length-to-width ratio, has generally been found to be correlated with wind speed and slope. From a modeling perspective, however, failure to consider the impact of containment on fire spread can only result in overestimation of total area burned, containment times, and resources utilized.

CFES 2's Containment module accommodates specification of the eccentricity of fires by FDL for each RFL. More importantly, it incorporates a containment algorithm that features a representation of the ratio of line building to ROS as a first order differential equation (Fried and Fried 1996). This equation is amenable to solution via Runge-Kutta approaches, can accommodate any mathematically represented shape (not just ellipses), and can be extended to model a parallel attack under which fireline is built at some distance away from and parallel to the fire in conjunction with firing-out or setting backfires.

SIMULATION OUTPUTS

CFES-IAM simulation outputs included expected annual area burned and number of fires by size class, along with the number of ESL fires, resource utilization, mission and suppression costs, and containment success. CFES2 extends these outputs, allowing for estimation of the variation to be expected in each.

In repeated simulations, the number of ESL fires or the area burned in contained fires are very high in a few years – as much as two to ten times the median. Presented in a percentile or odds table that includes extreme, mean and median summary statistics, this information can be both understandable and useful to fire planners and their clientele. It is important to know the magnitude of the differences between mean outcomes and extreme outcomes, since any fire organization that concentrates on preparing for average fire years will be ill-prepared to handle the worse-than-average years.

IV. Operation

This chapter describes the program interface and system requirements for running CFES2 and provides instructions for saving and retrieving data files containing CFES2 inputs and outputs.

SYSTEM REQUIREMENTS

CFES2 will run on any Intel™-compatible 286 or better machine, but realistically, a 486 DX2/66 is the minimum configuration suitable for running simulations. A fast hard disk or RAM disk will significantly enhance simulation speed, especially when simulation results are being saved to files.

A computer with 1 Megabyte of RAM is adequate for entering or editing input data. However, 4 Megabytes of RAM are needed to run simulations. Because input data are stored in random access memory (RAM), it may be possible to conduct short (10-20 year) simulations with small data sets on a machine with as little as 1 Megabyte of RAM, however, larger data sets will quickly generate an out of memory error and "crash" the program.

Although a hard disk is not required to enter or edit input data, since input data (*.CF2) files rarely exceed 200 kilobytes. A hard disk is required to write simulation outputs to files. One hundred year simulations can easily generate dispatch list (*.CS4) files that exceed 100 megabytes, event list (*.CS3) files that exceed than 10 megabytes, and annual summary (*.CS2) files that exceed 500 kilobytes.

CFES2 was designed using a color monitor, and has not been extensively tested on monochrome monitors. Entering the case sensitive parameter `ReduceColors` on the CFES2 command line <u>may</u> enhance readability on monochrome and composite monitors, but the use of a color monitor is strongly advised.

CFES2 does not generate <u>any</u> printed reports. However, it is possible to write out all input data and simulation results into comma-delimited ASCII files, which can then be imported into a relational database for archiving, analysis, or generation of printed reports. These files can also be imported into non-relational database or spreadsheet programs, although the types of analysis that can then be performed are more restricted.

INSTALLING CFES2

The best way to install CFES2 on your computer is to run CFESINST, an installation program which copies the CFES2 executable file onto a computer's hard disk along with essential run-time modules, a demonstration data set, and late-breaking release notes supplementing this User's Guide:

1. Insert the CFES2 distribution disk in the disk drive if installing from disk, or check that the files CFESINST.EXE, CFES2.ARX and RELNOTES.TXT are present in a single directory on the hard disk if installing from there.

2. To install from DOS, log to the drive containing the distribution disk (or the directory containing the distribution files) and type `CFESINST`. To install from Microsoft® Windows™, double-click on `CFESINST.EXE` in the File Manager (in Windows™ 3 .x) or Windows Explorer™ (in Windows 95™ or Windows NT™).
3. Follow the on-screen instructions to confirm the source and destination directories. Accepting "CFES2" as the target directory for program installation is strongly encouraged.
4. Review the release notes for late-breaking information not included in this User's Guide.

RUNNING CFES2

CFES2 has two operating modes: (1) *entry/edit* and (2) *execution*. Both modes are controlled by a menu system. Context-sensitive help screens are always available by pressing **`<F1>`**.

Entry/Edit Mode

The new user will spend a great deal of time in entry/edit mode entering data into the program's many entry/edit screens. When data is entered, it should be saved in an input data (*.CF2) file so that it can be re-loaded during subsequent entry/edit sessions. The authors strongly advise saving input data every 20-30 minutes during an entry/edit session, and maintaining systematic backups in case input data becomes corrupted. When entry of input data is complete, activity shifts to execution mode, but the entry/edit mode will often be revisited to review and correct simulation parameters, perform sensitivity analyses, or conduct "what-if" simulations.

Execution Mode

CFES2 is in execution mode when running simulations. Simulations require entry or loading of a complete set of input data. If you wish to write simulation results (e.g., event lists) to files, this must be called for before invoking execution mode. Some simulation outputs can be viewed and output displays can be changed in execution mode; ongoing simulations can paused, resumed or halted using the ***Output screen selection*** menu which pops-up when **`<F10>`** is pressed.

Starting CFES2

To start the CFES2 program from DOS, change to the directory containing the CFES2 software and type `CFES2`. After a brief splash screen that displays the program name, authors, and version number, the CFES2 "desktop" will appear (Figure 7).

CFES2 may also be started by double-clicking the program name File Manager ™ (in Windows™ 3.x) or Windows Explorer ™ (in Windows 95™ and Windows NT™). CFES2 may also be added to the start menu or as a desktop icon. (Consult your operating system documentation for instructions.) If you set up a file association between the "CF2" extension and CFES2, then *.CF2 files can be opened from File Manager ™ (in Windows™

3.x) or Windows Explorer™ (in Windows 95™ and Windows NT™), or by double clicking on its name or icon.

Starting CFES2 with command line parameters

To start CFES2 with a command line parameter (Table 2), enter the desir ed parameter after **`CFES2.`**

Table 2. Command line parameters.

Parameter	Effect
`novice`	Data in ***Production Rates➨Edit*** and ***Stations➨Edit*** entry/edit screens cannot be changed (to protect data integrity).
`ReSort`	All files loaded into CFES2 will be re -sorted by the criteria specified via the ***Settings, Sorting Preferences*** menu option at the time of loading.
`ReduceColors`	May improve screen readability on monochrome monitors

For example, to start CFES2 on a machine with a monochrome monitor (as noted above), you would type:

`CFES2 ReduceColors` **`<enter>`**

Specifying a data file at startup

To start CFES2 and load an input data (*.CF2) file with one command, type `CFES2 file name` at the DOS prompt, where `file name` is the name of the *.CF2 file that you wish to load. CFES2 will start and immediately load the selected file. When loading a *.CF2 file into CFES2 using this method, the file suffix may be omitted. For example, the demonstration data set in the file SCUDEMO.CF2 can be loaded by typing:

`CFES2 SCUDEMO` **`<enter>`**

Using the Mouse

If CFES2 is running in DOS, or in a full -screen DOS window under Windows, the mouse cursor will appear as a small, cyan diamond in a pink rectangle, and will be active if you have a DOS mouse driver loaded in memory. Under Windows ™ 3.x, you may also have to load a DOS mouse driver in the DOS shell under which CFES2 is run. If CFES2 is run under Windows 95™, the mouse cursor will appear the same as it does in the Windows 95™ environment, and will be active in CFES2. The mouse can be used to sele ct a menu option, select a field in an entry/edit screen for editing, call -up help, and finish or cancel editing activity. Left click selects, except in the case of +/ - entry/edit fields, where left clicks increment the field value. On 3 -button mice, a left-middle click has the same effect as **`<Ctrl><Enter>`**: it closes an entry/edit screen, carrying out all changes specified on that screen. The middle button (left -right on 2-button mice) calls up a context -sensitive help screen, and a right click is equivalen t to **`<Esc>`**: it will back you up one menu level if in a menu system, or quit an entry/edit screen without registering any changes to the data held in memory.

```
Load or save CFES2 data files
 Files  Entry/Edit  eXecute  Tables  Output  Dos  Settings  Help          Quit




 ┌────────────Data Status──────────┐      ┌──────────Directories──────────┐
 │                                 │      │  Start: C:\CFES2              │
 │                                 │      │   Read: C:\CFES2              │
 │                                 │      │   Save: C:\CFES2              │
 │                                 │      │ Output: C:\CFES2              │
 │              FMAZs:   0         │      │ Export: C:\CFES2              │
 │               RFLs:   0         │      │                               │
 │          Resources:   0         │      │                               │
 │           Stations:   0         │      │                               │
 │ Control conditions:   0         │      │                               │
 │   Production Rates:   0         │      │                               │
 │          Responses:   0         │      │                               │
 │          Behaviors:   0         │      │                               │
 │      RAM available: 14,105 K-bytes     │                               │
 │             Status: IDLE        │      │                               │
 └─────────────────────────────────┘      └───────────────────────────────┘
  CFES2 version number 2.00                         01:58:26 pm 01/01/1997
```

Figure 7. The CFES2 desktop immediately following program start -up.

THE MENU SYSTEMS

The CFES2 user interface consists of:

- Drop-down and pop-up menus and sub-menus
- Entry/edit and dialog screens
- Help screens and one-line help prompts

Menu choices can be invoked via a click of the mouse, selected via cursor movement keys and then invoked by pressing **`<Enter>`**, or invoked by pressing the capitalized letter in the desired menu option (this is not always the first letter, e.g., ***eXecute***).

Menus or menu choices that cannot be selected (because they are inappropriate in the current context) appear "grayed out." For example, ***Tables*** cannot be selected when you first start CFES2 because a simulation must be initiated before there are any outputs to view.

A one-line help prompt screen appears at the top of the CFES2 desktop describing the function of a highlighted menu choice or the contents of the current field on an entry/edit screen. More detailed help can be summoned by pressing **`<F1>`**, or pressing the left and right mouse buttons simultaneously.

When a menu choice on a drop-down or pop-up menu leads to a sub-menu, this is indicated by a right pointing arrow next to the choice; menu choices followed by an ellipsis (…) lead to dialog screens on which the user is prompted for further information. Any sub-menu can be exited by pressing **<Esc>**, and repeated presses of **<Esc>** in entry/edit mode will eventually return you to the CFES2 desktop.

Main Menu Overview

The main menu on the CFES2 desktop contains 9 choices, most of which open drop-down menus when invoked (Figure 8).

Files

This drop-down menu provides choices for retrieving (loading) an existing input data (*.CF2) file, saving the data in memory to a file, listing files and directories on your file system, reporting the free space available on the file system selected for your save directory, and for writing out the data in memory to comma-delimited ASCII files.

Entry/Edit

This drop-down menu is used to access the entry/edit screens for entering and/or editing input data.

eXecute

This menu choice initiates a simulation using the data in memory.

Tables

This menu choice switches from the CFES2 desktop to the output display screens for the most recently initiated simulation.

Output

This drop-down menu is used to specify which simulation outputs to write to files.

Dos

This menu choice opens a DOS shell from within the CFES2 program.

Settings

This drop-down menu is used to specify several parameters that control CFES2 program operation, or to save these preferences in the binary file CFES2.PRM.

Help

This drop-down menu choice is used to access CFES2's help screens.

Quit

This menu choice is used to exit the CFES2 program. The data currently in memory is lost upon exiting, so be sure to save any permanent changes or additions to the input data before invoking this choice.

Output Screen Selection Menu Overview

A pop-up menu for output screen selection can be summoned when in execution mode by pressing **<F10>**. When this menu is accessed, simulation activity pauses while the user selects the desired output screen to monitor, or until the menu is canceled by pressing **<Esc>**. Four menu choices are available:

Displays

This menu choice is used to select an output screen to display while in execution mode. The display options include:

- Single-year summary of acreage burned, and expected numbers of fires, by size class, for the current year, by FMAZ or for a Ranger Unit as a whole
- Multi-year summary of acreage burned and expected numbers of fires, by size class, for all years simulated, by FMAZ
- Event list of simulated fires
- Dispatch lists for firefighting resources (if dispatch list display has been enabled via the ***Settings➨eXecution*** menu choice)

Pause

This menu choice suspends all simulation activity. This can be useful for perusing output screens during the middle of a simulation. Simulation activity can be resumed by pressing **<F10>** again and then invoking the *Resume* choice.

Resume

This menu choice resumes a CFES2 simulation from the point where it was paused.

Halt

This menu choice immediately terminates an ongoing simulation, and returns the program to entry/edit mode.

```
name/code/fuel/slope/density, simulation limits, representation, # of RFLs
 Files  Entry/Edit  eXecute  Tables  Output  Dos  Settings              Quit

          Unitwide          »
          Fmaz              »     Description
          Control conditions      Output size classes
          Production Rates  »     Cost size classes
          Locations         »     Backup and structure protection
          Stations          »
          Resources         »            Start: C:\CFES2
          Behaviors                       Read: C:\CFES2
                                          Save: C:\CFES2
                                        Output: C:\CFES2
                 FMAZs:   0             Export: C:\CFES2
                  RFLs:   0
             Resources:   0
              Stations:   0
    Control conditions:   0
      Production Rates:   0
             Responses:   0
             Behaviors:   0
         RAM available: 14,018 K-bytes
                Status: IDLE

  CFES2 version number 2.00                          04:13:34 pm 01/01/1997
```

Figure 8. The ***Entry/Edit*** menu and its ***Fmaz*** sub-menu are open on the CFES2 de sktop.

DATABASE RECORD TYPES

CFES2 stores input data in a customized relational database with ten *record types*:

1. Ranger Unit
2. Ranger Unit Labels
3. FMAZ (Fire Management Analysis Zone)
4. RFL (Representative Fire Location)
5. Control Condition
6. Production Rate
7. Response
8. Stations
9. Resources
10. Behaviors

Storing these records in memory dramatically increases simulation speed, because they are repeatedly accessed during simulations. For the most part, the organization of CFES2 entry/edit screens corresponds to these record ty pes.

Because of the relational dependencies among these record types, care must be taken when deleting records to ensure that internal database links are not destroyed. In the section that follows, record types that are especially vulnerable to this kind of corruption are duly noted.

WORKING WITH FILES IN CFES2

File Types

CFES2 stores input data in compact, record-variant, binary input data (*.CF2) files for speedy access and efficient storage. While the internal structure of these files may change as new features and enhancements are added to CFES2, future releases of the program will always be backwards compatible with files created under earlier versions. No such effort will be made to ensure forward compatibility.

It is possible to write out the data stored in input data (*.CF2) files to comma-delimited ASCII files. These exported files are designated by the extension “CD?” (Hint: Remember that they contain **C**FES2 **D**ata), where “?” is a digit between 0 and 9 corresponding to a particular record type. These files can be easily imported into most relational database and spreadsheet programs for further processing, printing and analysis, or viewed in a text editor.

CFES2 simulation outputs are written to comma-delimited ASCII files designated by the extension “CS?” (Hint: Remember that they contain **C**FES2 **S**imulations), where “?” is the digit 2, 3, or 4 depending on the type of output data. The extension “CS1” was used to designate a CFES-IAM output file.

A number of parameters that govern program operation are stored in a small binary file named CFES2.PRM. This file will be created (or overwritten if it already exists) whenever ***Update*** is selected from the ***Settings*** drop-down menu.

*Loading an Existing *.CF2 Input File*

To load an existing *.CF2 input file, select ***Retrieve*** from the ***Files*** drop-down menu. This opens a dialog screen. First identify the drive on which the file resides from the valid drive list on this screen, using the **<+>**, **<->**, and **<Space>** keys to step forward or backward through the list (or cycle forward through the list using the left button of the mouse) until the desired drive is displayed in the selection field.

Proceed to directory and file selection by pressing **<Ctrl><Enter>**. This calls up a pick-list of the input data (*.CF2) files and file directories on the selected drive. Use the cursor movement keys to highlight a file for retrieval, or to the directory containing the desired file. When the desired file is highlighted, execute the load operation by pressing **<Enter>**. If you decide not to load a file for any reason, press **<Esc>**. Note that directories are distinguished from files by the notation `<dir>` in the second column of the pick list. Parent directories are denoted by “ . .”, and selecting “ . .”moves you up the directory tree.

If you have made changes to data already loaded in memory and want to keep these changes, you must save these changes before loading a new input data (*.CF2) file (see next section). Retrieving an input data (*.CF2) file erases all input data currently stored in memory and replaces it with the data stored in the file.

*Saving a *.CF2 Input Data File*

Select ***Save*** from the ***Files*** drop-down menu to save the data currently in memory to an input data (*.CF2) file. This opens a dialog screen on which you should enter or edit the full path name (including drive letter, colon and backslash) for the directory to which you wish to save the file. If the specified directory does not exist, CFES2 will display an error message to that effect.

Next, enter a file name (without the "CF2" extension) under which the data should be saved. To execute the save operation, press **<Ctrl><Enter>**; press **<Esc>** to cancel. If a file with the same name already exists, it will be overwritten, and its data will be irretrievably lost.

*Exporting Input Data as *.CD? Files*

The data held in memory can be written out to comma-delimited ASCII (*.CD?) files for import into a relational database (e.g., Access™, Paradox™, or Oracle™). The ten record types in the CFES2 relational database each have a corresponding type of *.CD? file (where "?" is one of the digits 0, 1, …, 9), as documented in Appendix I.

To export the data in memory, select ***Export*** from the ***Files*** drop-down menu. This opens dialog screen in which you should edit the directory field, if desired, indicating the where the export files should be written. Any changes will be reflected in the default export directory name displayed on the right side of the CFES2 desktop. A new default can be made permanent by updating the CFES2.PRM file (via the ***Settings➨Update*** menu choice). Enter or edit the file name which will serve as the base name for all exported files; then, enter `Y` for the file types which should be exported, and `N` for those which should not. These choices will become the new defaults for the remainder of the CFES2 session. Finally, execute the export operation by pressing **<Ctrl><Enter>** or **<F2>**, or cancel it by pressing **<Esc>**.

Specifying Simulation Outputs to Save (.CS? Files)*

During or after a simulation, it is possible to view average annual statistics for the current year being simulated, either for the entire Ranger Unit for a particular FMAZ, or to view cumulative multi-year average statistics for a particular FMAZ. It is also possible to save this data to annual summary (*.CS2) files via the ***Annual stats*** menu choice on the ***Output*** drop-down menu.

Only one screen-full of information in an event or dispatch list can be viewed on the display during or after a simulation has been run, and data that has scrolled off the screen is lost. Event and dispatch information can be written to event list (*.CS3) and dispatch list (*.CS4) files, but this must be specified <u>before</u> executing a simulation.

The simulation outputs you will want to write to files will depend on the types of analyses that you plan to conduct. The spatially and temporally aggregated summary statistics stored in annual summary (*.CS2) files is sufficient for performing many types of analyses.

A wealth of detailed simulation outputs can be written to event list (*.CS3) and dispatch list (*.CS4) files, but these can also quickly fill your hard disk.

Invoke the ***Specify outputs to save*** menu choice on the ***Output*** menu to specify which simulation outputs to write to *.CS? files (Figure 9). This calls up a dialog screen on which you should enter or edit the full path name of the directory to which CFES2 simulation outputs are to be saved, including the drive letter and colon (e.g. `,C:\PLANNING\CSO`). While not an editable field, the valid drive list may be helpful by indicating the valid drive letters accessible to the user on or from the computer on which CFES2 is running.

```
Directory for saving simulation output (.CS?) files, e.g., C:\PLANNING\CSO
                             +-------------------------------------------------+
                             ¦                                                 ¦
                             ¦ Valid Drive List: ABCDGHJW                      ¦
                             ¦                                                 ¦
                             ¦ Directory:C:\CFES2                              ¦
                             ¦                                                 ¦
                             ¦ Output File Name: SCUDEMO .CSx                  ¦
 +------------Data Status----¦                                                 ¦
 ¦          Input File: SCUDE¦ Simulation ID: SCUDEMO                          ¦
 ¦         Output Name: SCUDE¦                                                 ¦
 ¦  Created by version: 1.94 ¦ Append existing files: N                        ¦
 ¦     Date last saved: 06/05¦                                                 ¦
 ¦               FMAZs:   6  ¦ Outputs to Save                                 ¦
 ¦                RFLs:  26  ¦  SimKey    --CSK Y                              ¦
 ¦           Resources: 107  ¦  Summary   --CS2 N                              ¦
 ¦            Stations:  48  ¦                  N -Include averages            ¦
 ¦  Control conditions:   8  ¦                  Y -Include Year Totals         ¦
 ¦    Production Rates:  85  ¦                  Y -Include FDL detail          ¦
 ¦           Responses: 738  ¦                  N -Include FDL sums            ¦
 ¦           Behaviors:  16  ¦  Events    --CS3 N                              ¦
 ¦       RAM available: 41,28¦  Dispatch  --CS4 N                              ¦
 ¦              Status: IDLE ¦                  N -Include all resources       ¦
 +---------------------------¦                                                 ¦
  CFES2 version number: 2.00 +-------------------------------------------------+
```

Figure 9. ***Outputs➨Specify*** outputs to save entry/edit screen open on the CFES2 desktop.

Specify a file name of up to 8 characters (subject to the limitations of your operating system, e.g., no spaces in DOS 6.22 and below). This will serve as the base name for all simulation output files written (e.g., SCUDEMO.CS2 and SCUDEMO.CS3 in the exam ple shown in Figure 9).

The simulation ID field, editable via the ***Entry/Edit➨Unitwide➨Labels*** menu choice, is displayed for informational purposes only. This label will be included on every output record to facilitate database management.

Entering a `Y` in the "append if files exist" field causes simulation information for all *.CS? file types to be appended to the specified files rather than overwriting them. This capability may be useful for collecting the results of several different simulations in one set of *.CS? files. However, if the simulation ID is not unique for each simulation, it will be more difficult to maintain a logical link between records associated with particular simulations in a database. However, each saved simulation record includes a date and time stamp set to the moment execution began. If the "append if files exist" field is set to N, existing simulation output files with the same name will be overwritten without warning.

The SimKey field on this entry/edit screen is not currently editable. The generation of a *.CSK file takes up very little disk space, and makes it possible to reduce redundancy in the other *.CS? files.

The *.CS? files to be saved can be specified by entering a Y in the appropriate fields at the bottom of the dialog screen.

Note that dispatch information for firefighting resources may be specified for all resources eligible for dispatch to each fire, regardless of their utilization, by specifying Y in the field indicating include all resources. An N in this field and a Y in the one above it causes dispatch information to be written in the dispatch list (*.CS4) file only for the resources actually dispatched to fires.

These specifications are registered by pressing **<Ctrl><Enter>** or **<F2>**, or cancelled by pressing **<Esc>**.

CHANGING PROGRAM PARAMETER SETTINGS

There are two types of user-accessible program settings that affect program operation: *Execution parameters*, which control the actual simulation, and *Sorting* preferences, which primarily govern the sort order of data in entry/edit screens and pop-up pick lists. Entry/edit screens to specify both are accessed via the ***Settings*** drop-down menu. Any changes made to these settings can be made permanent via the ***Settings➨Update*** menu choice.

Execution Parameters

Random Seed

Entering any numeral other than 0 for this parameter forces non-random (repeatable) operation. There are therefore 9 possible repeatable simulations that can be generated from any CFES2 data set. The default value for this parameter is zero, for obvious reasons. Using a value other than zero permits a repeatable demonstration of the simulation process. It may also be useful when debugging input data.

Maintain Dispatch List Display

Set this parameter to Y if screen display of the dispatch lists for individual fires is desired. If it is set to N, simulation speed is enhanced, but it is not be possible to select the ***Dispatch*** menu choice from the ***Output screen selection*** menu. Real-time display of dispatch lists during simulations can be useful in assessing of the reasonableness of the dispatch lists. The screen display of dispatch information includes resource identifiers, response times (RT), and production rates (PRATE) in chains per hour. All resources dispatched are displayed, regardless of their assignment to building fireline, backing up other resources, or protecting structures, or even if they are not utilized at all. It is possible to determine which resources were actually “used” on a given fire by pausing the simulation, switching to the event list display, and noting the containment time (Tc).

Dispatch List Display Delay

A non-zero value for this parameter causes a delay between screen writes of dispatch records equal to the value (in tenths of seconds). This can be useful for slowing down the display. If the maintain dispatch list display parameter is set to **`N`**, the value specified for this parameter is ignored.

Ignore Backup Specifications

Set this parameter to **`Y`** to disable backup relationships between firefighting resources. No adjustments will then be made to any resource’s fireline production rate based on the mix of resources dispatched to a fire. This parameter can be useful in debugging simulation data sets, and for conducting sensitivity analysis on backup assumptions.

Ignore Structure Protection

Set this parameter to **`Y`** to disable structure protection requirements. All dispatched resources will be considered to be available for fireline production. This parameter can be useful in debugging simulation data sets, and for conducting sensitivity analysis on structure protection assumptions.

Number of Years to Simulate

Choosing the ***eXecute*** menu choice on CFES2’s main menu initiates simulation of the number of years of fire activity specified by this parameter. The default value (3) provides a reasonable simulation for demonstration purposes. Real analysis should be based upon simulations of a hundred years or more. Simulating one year of fire activity takes from 10 seconds to 5 minutes, depending on the size of the input data set and the processor speed of the computer.

Number of *.CF2 Backup Levels to Keep

If a value greater than zero is specified for this parameter, saving an input data (*.CF2) file causes the last saved version of the file to be resaved with the extension “CB1”. With a parameter value greater than one, if a *.CB1 file exists, it is saved to a file with extension “CB2” before the *.CF2 file is backed up to a file with extension “CB1”. With three backup levels, if a *.CB2 file exists, it first gets saved as a file with extension “CB3”, and so on.

Sorting Preferences

User defined sorting criteria are supported for four types of CFES2 input record types to facilitate data entry and edit operations: RFL, Production, Resources and Responses. For each of these record types a primary (and optional secondary) sort key can be specified. For example, if it is desired that RFLs appear sorted by RFL number (rather than the default order of FMAZ [primary] and control condition [secondary]) as you page through these records in the RFL based entry/edit screens, this can be easily specified using the **`<+>`**, **`<->`**, and **`<Space>`** keys to toggle the appropriate choice.

By default, response records are sorted by response time, but there is no reason that they cannot be sorted instead by RFL and/or resource identifier. Keep in mind that if sort orders are changed, these changes will also be apparent in the pick lists for accessing corresponding record types in entry/edit screens. For example, if RFLs are sorted by RFL number, then the pick list displayed when the ***Locations➨Responses*** menu choice is chosen will display RFLs by number; if sorted instead by FMAZ/CC or RFL description, they will appear in a different order. In some cases, the pick list order may appear strange at first; for example, if Resources are sorted by type, then the pick list summoned by ***Resources➨Responses*** will not be alphabetically sorted by either of the items displayed in the pick list window (resource ID or resource description).

Sorting response records may take up to a few minutes to complete. The main menu will appear when sorting is complete.

Users seeking to run repeatable simulations need to be aware that changing the sort order of RFLs may lead to different simulation outcomes, even with a constant, non-zero value for the random seed parameter.

Changes in sort order will also be reflected in the files saved after re-sort operations. To return to default sort orders at any time, simply specify `Default` for both the primary and secondary sort fields.

TEMPORARY EXIT TO DOS

The ***Dos*** main menu choice executes a shell in whatever version of DOS is loaded on the host machine (e.g., MS-DOS™ 7.0, if running in Windows 95™, or MS-DOS™ 3-6.22 with Windows™ 3.x). This feature is inoperative under Windows NT™. CFES2 and its input data still reside in RAM, but the program remains in a suspended state as long as the DOS shell is active. When temporary exit to a DOS shell is selected, the CFES2 desktop will disappear, and be replaced by a black on cyan DOS screen with the familiar C: prompt. Perhaps the most important thing to know about the DOS shell, particularly if you enter it accidentally with an errant key press, is that you get out of it by typing `exit`.

On a computer without Windows™, DESQview™, or some other multi-tasking operating system, the DOS shell can be a convenient way to temporarily switch to another task, checking e-mail, for example, without having to close down CFES2. However, when in the DOS shell, you will probably have at least 18K less free memory than would have been available if the CFES2 program were not loaded. Be careful not to load RAM resident programs in a DOS shell under CFES2, as this may prevent you from returning to your CFES2 session, possibly forcing you to reboot your computer.

One note of caution about the DOS shell: it is possible to load another copy of CFES2 from the DOS shell spawned under your first CFES2 session (and a third copy under the second session's DOS shell, and a fourth copy under that, etc.). This has the potential to become very confusing, and could easily result in the "wrong" version of your data being saved last. Thus, the authors do not advise running CFES2 "under" CFES2.

FIELD EDITING IN ENTRY/EDIT SCREENS

Every menu option in CFES2 that does not lead to an immediate action summons some kind of entry/edit screen containing one or more entry/edit fields. Some common entry/edit screen protocols are:

- No changes are committed until pressing **<Ctrl><Enter>**, **<F2>,** or an equivalent key combination, which closes the screen and effects the changes in RAM
- Pressing **<Esc>** will always abandon all changes to the current record and close the open entry/edit screen
- You may generally advance through the fields in logical o rder using **<Tab>** (forward direction) or **<Shift><Tab>** (reverse order)
- It is possible to move directly to any field using the mouse
- Line one contains a brief help prompt for the current field
- **<F1>** will summon help for the current entry/edit screen
- Boolean fields will only accept entry of Y (for yes) or N (for no)
- Fields marked +/- or referred to as such in the help can only be incremented using the **<+>**, **<->**, and **<Space>** keys or the left mouse button; there are a few cases in which integer numbers are selected in this fashion
- On color monitors, editable fields are black on gray; the current (active) field is black on green
- Wherever you must enter a record identifier (e.g., a FMAZ or control condition code) from a different kind of record than is displayed in th e current entry/edit screen, **<F8>** will pop-up a menu of valid choices

- In any entry/edit screen text field, the following line editing commands can be used:

Keystroke commands useful in entering or editing text in fields are listed in Table 3.

Table 3. Keystroke commands.

Keystroke	Action
<Enter>	Accept field
<Esc>	Quit without changing line
<Left> or <Ctrl><S>	Cursor left one character
<Right> or <Ctrl><D>	Cursor right one character
<CtrlLeft> or <Ctrl><A>	Cursor left one word
<CtrlRight> or <Ctrl><F>	Cursor right one word
<Home> or <Ctrl><Q><S>	Cursor to beginning of line
<End> or <Ctrl><Q><D>	Cursor to end of line
<Del> or <Ctrl><G>	Delete character at cursor
<Bksp> or <Ctrl><H> or <Ctrl><Bksp>	Delete character at left of cursor
<Ctrl><End> or <Ctrl><Q><Y>	Delete to end of line
<Ctrl><Y> or <Ctrl><X>	Delete entire line
<Ctrl><Home>	Delete from beginning of line
<Ctrl><T>	Delete word to right of cursor
<Ins>	Toggle insert mode on and off
<Ctrl><R> or <Ctrl><Q><L>	Restore original contents of line

Except for Unitwide records, all CFES2 record types support specification of multiple records. In most instances, you can load the previous or next record of a given type into the associated entry/edit screen via **<PgUp>** and **<PgDn>**. Pressing **<F9>** or **<F10>** will load the first or last records in the linked -list, respectively.

To add a new record to an existing list you can either: (1) move to the last record in the list, then press **<PgDn>** to create a blank entry/edit screen, or (2) press **<F6>** to save changes to the current record (if any) and open a blank entry/edit screen.

The ***Production rates➨Edit rates, Stations➨Edit stations, and Locations➨Response times*** entry/edit screens are unusual in that they display data from more than one record to permit more efficient editing. Operational features peculiar to these entry/edit screens are noted in Chapter V.

The actions which can be performed in entry/edit screens via function keys and mouse clicks are summarized in Table 4.

Table 4. Function keys and mouse c lick controls for entry/edit screens.

Key/Click	Action
<F1>	Summons context sensitive help screen
<F2>	Performs same function as **<Ctrl><Enter>**, namely save changes to memory and close the entry/edit screen
<F6>	Stores changes specified in the current en try/edit screen and opens a blank entry/edit screen
<ctrl><F7>	Deletes currently displayed record from memory
<F8>	Pops up a pick list for the current field
<F9>	Displays the first record in a list
<F10>	In an entry/edit screen: displays the last recor d in a list In execution mode: calls up the ***Output screen selection*** menu
<left click>	Makes a menu selection or activates a field
<middle click> or <left and right click>	Calls up a context-sensitive help screen
<right click>	Same as **<Esc>**: backs out of menu or entry screen one level at a time
<middle and right click>	Performs same function as **<Ctrl><Enter>**, namely saves changes to memory and closes the entry/edit screen

V. CFES2 Inputs: A Reference Guide

This chapter documents the data that must be entered in CFES2's entry/edit screens before a simulation can be run. The chapter is organized with subheadings corresponding to the menu options under the ***Entry/Edit*** drop-down menu. The information in this chapter is summarized in CFES2's help screens.

UNITWIDE ➨ LABELS

Use this entry/edit screen to specify the name of the Ranger Unit, a three-character Ranger Unit code, and the names of the CFES2 coordinator and one or two assistants (Figure 10). A field is also provided for a simulation label that is included with all simulation output generated using this data. Because there is only one Ranger Unit record, the **<PgDn>**, **<PgUp>**, **<F9>**, and **<F10>** keys will have no effect in this entry/edit screen.

```
Enter the name of the ranger unit to be simulated
+------------------------------------------------------------------------+
|                                                                        |
| Ranger Unit: Santa Clara:  Alameda/C. Costa/S. Clara   Ranger Unit Code: SCU |
|                                                                        |
|       CFES2 coordinator:David Wachtel                                  |
|            Assistant 1: J. Keith Gilless                               |
|            Assistant 2: Jeremy S. Fried                                |
|                                                                        |
|       Simulation Label: Demonstration  Data Set                        |
|                                                                        |
|           Simulation ID SCUDEMO                                        |
|                                                                        |
+------------------------------------------------------------------------+
```

Figure 10. ***Unitwide➨Labels*** entry/edit screen.

UNITWIDE ➨ SEASONS

Seasons are defined by ranges of dates (Figure 11). These dates should correspond to those used to stratify historical fire data for the estimation of fire occurrence and behavior parameters. Only the last day of each season needs to be entered, because the last day of one season automatically determines the first day of the next. [1]

[1] The implementation of season specification in this entry/edit window is somewhat California-centric, and will be modified in a later release for areas with multiple periods of high fire danger.

```
Enter last day of early Low season
+--------------------------------------------------------------------------------+
|                                                                                |
|                                                                                |
|   Ranger Unit Code: SCU                                                        |
|                                                                                |
|             +------------------------------------------+                       |
|             |                  Lower        Upper      |                       |
|             |                  Bound        Bound      |                       |
|             |            Low: 01/01   to   04/23       |                       |
|             |     Transition: 04/23   to   05/14       |                       |
|             |           High: 05/14   to   11/05       |                       |
|             |     Transition: 11/05   to   12/03       |                       |
|             |            Low: 12/03   to   12/31       |                       |
|             |                                          |                       |
|             +------------------------------------------+                       |
|                                                                                |
|                                                                                |
+--------------------------------------------------------------------------------+
```

Figure 11. ***Unitwide➨Seasons*** entry/edit screen.

UNITWIDE ➨ OCCURRENCE

CFES2 generates sequences of fires via a three -step process that is guided by parameters estimated from historical data:

1. For each day, a random draw from a Bernoulli (Fire Day) distribution determines whether one or more fires occur.
2. For days on which one or more fires occur, the number of fires (Multiplicity) for that day is randomly drawn from a ge ometric distribution.
3. The start times for each fire (Time of Day) are randomly drawn from a beta or poisson distribution.

For details on the how these parameters are fit from historical data, see Fried and Gilless (1988).

The parameters for these distribu tions must be entered on the ***Unitwide➨Occurrence*** entry/edit screen (Figure 12). Distribution types can be selected with the **<+>**, **<->**, and **<Space>** keys. Parameters are entered directly.

Because Fireday is always described by a Bernoulli distribution, this is the only distribution supported for that parameter. Select the Bernoulli distribution, then enter the parameter for each season. Larger values of the Bernoulli parameter indicate greater probabilities of one or more fires occurring on any given day in t hat season.

Because Multiplicity is always described by a geometric distribution, this is the only distribution supported for that parameter. Smaller values of the geometric parameter lead to simulations with more multiple fire days.

The choice of Time of Day distribution depends on the historical fire activity in a Ranger Unit. In general, Ranger Units with fewer fires overall (and less bunching of those fires at mid-day) are likely to be better fit by a beta distribution; others may be better fit by the poisson distribution. Sensitivity analysis of CFES2 indicates that the beta distribution is a more conservative choice in that it less likely to result in simultaneous fires. In either case, the time of day which corresponds to the left endpoint of the dist ribution must be entered for each season. If there is insufficient data to estimate Time of Day parameters separately for each season, it is permissible to generate a pooled estimate, and to enter the resulting parameter(s) for each season.

```
Select distribution type with +/-
+--------------------------------------------------------------------------------+
|                                                                                |
|   Ranger Unit Code: SCU                                                        |
|                                                                                |
|                                                                                |
|           Fire Day                                Multiplicity                 |
|           Bernoulli                               Geometric                    |
|                                                                                |
|        Low:0.0442                                 Low:0.9265                   |
|  Transition:0.2154                         Transition:0.6788                   |
|       High:0.55                                  High:0.5072                   |
|                                                                                |
|                                                                                |
|           Time of Day                         Time of Day                      |
|           Beta                                Endpoint                         |
|                                                                                |
|        Low:2.1993 2.9418                          Low:5                        |
|  Transition:2.1993 2.9418                  Transition:5                        |
|       High:2.1993 2.9418                         High:5                        |
|                                                                                |
|                                                                                |
+--------------------------------------------------------------------------------+
```

Figure 12. ***Unitwide➨Occurrence*** entry/edit screen.

UNITWIDE ➨ DAWN/DUSK

The Dawn and Dusk times for each season limit the range of hours during which aircraft can be dispatched to a fire (Figure 13). Fires that start after dusk or before dawn will not receive air tanker or helicopter support in simulations. Recognizing that the times of da wn and dusk vary continuously over the year, the user is expected to specify approximate times by season.

```
Enter time in 24:00 hour format
+-------------------------------------+
|                                     |
|       Ranger Unit Code: SCU         |
|                                     |
|       Season     Dawn      Dusk     |
|                                     |
|       Low        08:00     17:30    |
|       Transition 07:30     18:00    |
|       High       06:00     19:00    |
|                                     |
+-------------------------------------+
```

Figure 13. ***Unitwide➨Dawn/Dusk*** entry/edit screen.

UNITWIDE ➨ SIZE CLASSES

Use this entry/edit screen (Figure 14) to specify the upper bounds of the five unit -wide size classes in which statistics for "contained" simulated fires will be assigned. Fires larger than the upper bound of the fifth size class will be classed as Ranger Unit -wide ESL fires in Ranger Unit-wide summaries regardless of whether they were contained within the relevant FMAZ simulation size limit.

```
Enter upper bound of output size class 1
+--------------------------------------------------------------------------------+
|                                                                                |
|                                                  Ranger Unit Code: SCU         |
|                                                                                |
|                           Lower Bound    Upper Bound                           |
|                                 0.00           0.25                            |
|                                 0.25           3.00                            |
|                                 3.00          10.00                            |
|                                10.00          50.00                            |
|                                50.00         100.00                            |
|                                                                                |
+--------------------------------------------------------------------------------+
```

Figure 14. ***Unitwide➨Size class*** entry/edit screen.

FMAZ ➨ DESCRIPTION

Although FMAZ-level data is entered in several different entry/edit screens, FMAZs can only be defined (created) or deleted in a ***Fmaz➨Description*** entry/edit screen (Figure 15). Each FMAZ must be designated with a u nique identifier of up to five characters on this entry/edit screen. A longer text description (up to 50 characters) of the FMAZ can be entered in the description field. The habitation (population) density field (selected with **<+>**, **<->**, and **<Space>** keys as `Low`, `Medium` or `High`) is currently only descriptive, but may be used for analytical purposes in later versions of CFES2. Simulated fires which exceed the simulation size limit or which cannot be contained within the simulation time limit will be declared ESL fires. Simulation size and time limits typically vary among FMAZs. These limits should reflect the threshold beyond which the assumptions underlying the Containment module no longer hold (i.e., a fire is so big that is has likely spread over a ridge, or has not been contained before suppression has entered an extended attack mode). They may also reflect policy considerations such as differences in the values at risk. The percent of fire load field should be used to enter the percent of all fires in the R anger Unit expected to start in this FMAZ.

```
Enter the 5-letter code for a Fire Management Analysis Zone
+------------------------------------------------------------------------------+
| +--------------------------------------------------------------------------+ |
| | FMAZ identifier   Description                                            | |
| |     SCUAL         Fuel model A, low habitation density                   | |
| +--------------------------------------------------------------------------+ |
|                                                                              |
|              Habitation Density Class (+/-): Low                            |
|                       Simulation Size Limit: 300      acres                 |
|       Simulation Time Limit (hours:minutes):  2:00                           |
|                        Percent of Fire Load:  37.7                           |
|                                                                              |
|+------- ROS-BEHAVIOR LINK --------+   +-------- FDL-BEHAVIOR LINK --------+ |
||                                  |   |                                   | |
||            Fuel model: A3        |   |             Fuel model: A3        | |
||     Slope Class (+/-): 26-40 %   |   |      Slope Class (+/-): 26-40 %   | |
||      Herb Class (A/P): A         |   |       Herb Class (A/P): B         | |
||   Climate Class (+/-): 2         |   |    Climate Class (+/-): 2         | |
||       Weather Station: 43501     |   |        Weather Station: 43501     | |
||                                  |   |                                   | |
|+----------------------------------+   |       Low/Medium break: 10        | |
|                                       |      Medium/High break: 25        | |
|                                       |                                   | |
|                                       +-----------------------------------+ |
+------------------------------------------------------------------------------+
```

Figure 15. ***Fmaz➨Description*** entry/edit screen.

The two boxed sets of entry/edit fields in the bottom half of the FMAZ Description entry/edit screen establish linkages between the FMAZ and the behavior records containing the parameters for ROS and BI distr ibutions. The ROS-behavior link is defined by: a two-character fuel code, slope class, herb class (annual [`A`] or perennial [`P`]), climate class (`1-4`), and weather station identifier. The FDL -behavior link is defined by the same parameters if FDL is based up on ROS. If it is based upon BI, however, then a `B` should be substituted for `A` or `P` in the herb class field. The FDL -behavior link also requires specification of the ROS or BI breakpoints that separate low from medium and medium from high FDL. It is the re sponsibility of the user to ensure that these breakpoints make sense (e.g., that the medium/high breakpoint is larger than the low/medium one).

To move among FMAZ records, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys. Paging down from the l ast record or pressing **<F6>** (New) will open a blank entry/edit screen into which new FMAZ information may be entered.

FMAZ ➨ OUTPUT SIZE CLASSES

The boundaries of the fire size classes for summarizing simulation results at the FMAZ are specified on the ***Fmaz ➨Output size classes*** entry/edit screen (Figure 16). The upper bound of the fifth size class and the lower bound of the escape size class and are automatically constrained to match the simulation size limit specified in the ***FMAZ ➨ Description*** entry/edit screen (Figure 15). Therefore, only the upper bounds of the first four fire size classes need be entered or edited (the lower bounds are filled in automatically). An error message is displayed if an upper bound is entered that is smaller than the upper boun d of the next smaller size class. To move among FMAZ records, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys.

```
Enter upper bound of output size class 1
+------------------------------------------------------------------------+
|                                                                        |
|                                                                        |
|                                                                        |
|  FMAZ Code: SCUAL     FMAZ Name: Fuel model A, low habitation density  |
|                                                                        |
|                                                                        |
|                         Lower Bound    Upper Bound                     |
|                              0.00           3.00                       |
|                              3.00          10.00                       |
|                             10.00          50.00                       |
|                             50.00         100.00                       |
|                            100.00         300.00                       |
|                                                                        |
|                                                                        |
+------------------------------------------------------------------------+
 | Control conditions:   8            |  |                              |
 |   Production Rates:  85            |  |                              |
 |         Responses: 738             |  |                              |
 |         Behaviors:  16             |  |                              |
 |     RAM available: 13,925 K-bytes  |  |                              |
 |            Status: IDLE            |  |                              |
 +------------------------------------+  +------------------------------+
  CFES2 version number: 2.00                          12:57:16 am 06/05/1997
```

Figure 16. ***Fmaz➨Output size class*** entry/edit screen.

FMAZ ➨ BACKUP SPECIFICATION AND STRUCTURE PROTECTION

CFES2 is the first initial attack model to explicitly account for the fact that firefighting resources often rely on other resources to back them up. This is important in simulating containment because the presence of a *backup resource* may enable or extend the line - building productivity of a *backed-up resource*, though perhaps at the cost of the backup resource's own capacity to produce fireline. CFES2 allows the specification of up to eight such relationships for an FMAZ. Currently, only utilize backup relationships specified between ground based resources (e.g., hand crews, engines, and bulldozers) are actually reflected in simulations. Each category of backed -up resource can rely on only one category of backup resource, although a resource category may backup more than one category of backed-up resource. If more than one backup resource category is spe cified for a category of backed-up resource (e.g., secondary engines backed up by both primary engines and secondary hand crews) only the first backup relationship will be in effect.

Backup relationships are specified in the F ***maz➨Backup and structure protection*** entry/edit screen. As with all ***Fmaz*** Entry/Edit screens, the **`<PgUp>`** and **`<PgDn>`** keys change the currently selected FMAZ. The top half of this entry/edit screen contains eight rows of fields in which to specify for backup relationships (Figure 17). The values in this entry/edit screen are, with the exception of the Boolean fields, are all selectable using the **`<+>`**, **`<->`**, and **`<Space>`** keys. CFES2 does not check this data for logical consistency -- it is up to the user to be certain that the backup relationsh ips specified make sense.

```
Resource type to be backed up: category
+------------------------------------------------------------------------------+
|                                                                              |
| FMAZ Code: SCUAL                                                             |
| FMAZ Name: Fuel model A, low habitation density                              |
|  Backed-up Resource    Backup Resource                       Backup   Elimin. |
|  Type       Experience Type       Experience  Importance      prod.    drop.  |
|  Engine     Secondary  Engine     Primary     Desired          Y        N     |
|  Handcrew   Any        Engine     Any         Required         N        Y     |
|                                                                N        N     |
|                                                                N        N     |
|                                                                N        N     |
|                                                                N        N     |
|                                                                N        N     |
|                                                                N        N     |
|                                                                              |
|     Resources Required for Structure Protection                              |
|                      Quantity by Fire Dispatch Level                         |
| Type        Experience   Low       Medium      High                         |
| Engine      Any           0          1          2                           |
|                           0          0          0    Average Parcel Size    |
|                           0          0          0        0                  |
|                           0          0          0                           |
|                                                                              |
+------------------------------------------------------------------------------+
```

Figure 17. ***FMAZ➨Backup and structure protection*** entry/edit screen.

Backup Specification Fields

The resource categories to be backed -up are defined by both resource type and experience level. If `Any` is specified for experience level, then the backup relationship will apply to resources with either `Primary` or `Secondary` experience. As CFES2 builds the dispatch list for a fire, whenever a backed -up resource is added to the list, the program will search the entire dispatch list, including resources arriving before the backed -up resource, for the earliest arriving backup resource that has not already been committed to structure protection or to backup another resource.

The resource category to be used to backup the backed -up resource is also specified by experience level. If `Any` is specified, then resources with either `Primary` or `Secondary` experience can satisfy the backup relationship, and CFES2 would choose the first available resource of the specified resource type.

Backup relationships can be either `Required` or `Desired`. If `Required`, then the backed-up resource will not be productive unless a suitable backup resource is available. If `Desired`, then the backed-up resource will be productive regardless of whether or not a suitable backup resource it is available.

If a `Y` is entered in the backup pr oductive field, then a resource allocated to backup another will also be productive (i.e., its fireline production is unaffected by its backup role). An `N` in this field, however, means that a backup resource does not engage in producing fireline directly. If a `Y` is entered in the eliminates drop -off field then the fireline production rate of the backed -up resource will be constant if the appropriate backup resource is present.

Structure Protection Fields

For any FMAZ, the numbers (by FDL) of up to four cate gories of resources (defined by type and experience level) can be automatically allocated to structure protection instead of fireline production.

Average Parcel Size

The value entered for the size of the average parcel in the FMAZ on this entry/edit scree n does not affect simulation outcomes, but may be useful in analysis of structure losses.

To move among FMAZ records, use the **`<PgDn>`**, **`<PgUp>`**, **`<F9>`** (First), and **`<F10>`** (Last) keys.

FMAZ ➨ COST SIZE CLASSES

Users interested in tracking per acre suppression co sts over and above those costs accounted for by the mission cost values (entered in response records) can specify up to 14 cost size classes and associated per acre costs in this entry/edit screen (Figure 18). This cost tracking option is included in the s pirit of backward compatibility with CFES -IAM, and to facilitate comparisons with analyses conducted using cost -plus-net-value-change planning systems. For each simulated fire that is contained within the user -specified size and time limits, a suppression cost is assigned by multiplying fire size (in acres) by the per acre cost for the corresponding cost size class.

```
Enter the upper bound (in acres) for this cost size class.
+-------------------------------------------------------------------------+
|                                                                         |
|                                                                         |
|                                                                         |
|                                                                         |
|                                                                         |
| FMAZ Code: SCUAL     FMAZ Name: Fuel model A, low habitation density    |
|                                                                         |
|                                                                         |
|    Lower      Upper                        Lower      Upper             |
|    Bound      Bound       Cost            Bound      Bound       Cost  |
|  0          0.25          200.00      0          0              0.00  |
|  0.25       2             100.00      0          0              0.00  |
|  2          10             75.00      0          0              0.00  |
|  10         100           125.00      0          0              0.00  |
|  100        1000          100.00      0          0              0.00  |
|  1000       0               0.00      0          0              0.00  |
|  0          0               0.00      0          0              0.00  |
|                                                                         |
+-------------------------------------------------------------------------+
```

Figure 18. ***Fmaz➨Cost size classes*** entry/edit screen.

CONTROL CONDITIONS

A *control condition*, as defined in Fried and Gilless (1989), refers to a combination of environmental conditions such as vegetation, soils, slope, and accessibility; and management policies with respect to dispatch and tactics.

The ***Control condition*** entry/edit screen allows for the entry or editing of control condition codes of up to 6 characters and text description of up to 50 characters (Figure 19). Control condition codes must be unique—CFES2 will not allow creation of multiple control condition records with the same code. While control condition descriptions do not affect simulation outcomes, good descriptions can help in interpreting simulation results.

RFLs and fireline production rate records must be assigned a control condition in CFES2. If it is necessary to change a control condition code, it is permissible to do so on the ***Control condition*** entry/edit screen, and any RFL or production rate records referencing that control condition code will be updated. However, if a control condition record referenced by either an RFL or production rate record is deleted, this can irretrievably corrupt the input data (*.CF2) file . Therefore, control condition records should not be deleted unless you are certain that no references are made to them by any RFL or production rate record. Unreferenced control conditions do not affect simulation outcomes.

To move among control condition records, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys. Paging down from the last record or pressing **<F6>** (New) will open a blank entry/edit screen into which a new control condition may be specified.

```
Specify a control condition code to add to the master list
+------------------------------------------------------------------------+
|                                                                        |
| Control Condition Code: SCUAX1                                         |
|                                                                        |
| CC Descrip: Stanislaus: I a grass-F topo                               |
|                                                                        |
+------------------------------------------------------------------------+
```

Figure 19. ***Control condition*** entry/edit screen.

PRODUCTION RATES ➨ ADD RATES

If any production rate records exist, they can be accessed one at a time in the ***Production rates➨Add rates*** entry/edit screen (Figure 20) using **<PgDn>** and **<PgUp>**. The display order in this screen can be changed via the ***Settings➨Sorting preferences*** menu choice. The default sort order is a nested sort by control condition and resource category attributes (type, mode, owner, ICS class, and crew size). All resource category attributes except crew size can be selected using the **<+>**, **<->**, and **<Space>** keys.

```
Press <F8> to change control condition
+------------------------------------------------------------------------+
|                                                                        |
| Control Condition Code: SCUAX1                                         |
|                                                                        |
| +-----Resource------------------++--------Production------++----Dropoff--+ |
|  Type            Owner ICS  Crew  Feet Best Worst  α    ß   Distance Time |
|                                                                        |
| Engine    Mobil CDF   ICS1  2    1320  12   25   3.60 7.06   1280   20  |
|                                                                        |
+------------------------------------------------------------------------+
```

Figure 20. ***Production rate➨Add rates*** entry/edit screen.

Production rate data for each combi nation of control condition and resource type to be modeled can be obtained from the appropriate table in Lee et al. (1991) unless more appropriate data are available. The feet field refers to the number of feet for which the estimates of line construction time were made. The best and worst fields are for the shortest and the longest times, in minutes, required to complete the specified feet of line, and α (alpha) and β (beta) fields are for the parameters of the beta distribution that govern its shape (and the relative probability of drawing a short or long line construction time). Fireline production by any resource dispatched to a fire is determined by making a random draw from the appropriate production rate distribution

The two drop-off parameters are used to reflect the reduction in fireline production rate that can occur when crews become fatigued or engines expend their water. The reduction goes into effect once the drop-off distance of fireline has been constructed, thereafter the resource continues to fireline at a constant rate. This new rate is determined by dividing the distance in the feet field by the value in the drop -off time field.

To move among production rate records, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys. Paging down from the last record or pressing **<F6>** (New) will open a blank entry/edit screen in which a new production rate may be entered.

PRODUCTION RATES ➨ EDIT RATES

The ***Production Rates➨Add rates*** menu choice allows for editing all of the fireline production rates for a given control condition on one entry edit screen (Figure 21). The fields on this screen are identical to those on the ***Production Rates➨Edit rates*** entry/edit screen (Figure 20). Invoking the ***Production Rates➨Add rates*** menu choice calls up a pick list of control conditions. The entry/edit screen appears after a control condition has been selected from this list. You can navigate among the production rate records on the screen with **<Up>** and **<Down>** (or left-clicking with the mouse in the scroll bar on the right), and among the fields for a production rate record via **<Tab>** and **<Shift><Tab>**. To access the fireline production rates for other control conditions, use **<PgDn>**, **<PgUp>**, **<F9>** and **<F10>**. No changes are actually made to the data in memory until **<Ctrl><Enter>** is pressed, or a different control condition is selected. To cancel additions or changes to production rate records for the currently displayed control condition, press **<Esc>**.

```
Select resource type (+/-)
+-------------------------------------------------------------------------------+

 Control Condition Code: SCUAX1
 CC Descrip: Stanislaus: I a grass-F topo
 +-----Resource------------------++--------Production------++----Dropoff--+
  Type       Mode  Owner ICS  Crew  Feet Best Worst  α    ß   Distance Time
 Engine      Mobil CDF   ICS1  2    1320  12   25   3.60 7.06   1280    20
 Engine      Mobil CDF   ICS3  3    1320  16   42   2.10 6.51   1380    29
 Engine      Mobil CDF   ICS3  4    1320  14   38   1.98 6.41   1380    24
 Dozer             CDF   ICS2  1    1320  12   20   4.20 7.01   0       0
 Handcrew          CDF   ICS1  13   1320  48   73   4.02 7.04   2867    62
 Handcrew          CDF   ICS1  16   1320  42   62   6.02 6.02   2867    57
 Helicopter  Drop  CDF   ICS1  5    198   0    0    0.00 0.00   0       0
 Helicopter  Crew  CDF   ICS1  5    1320  72   97   4.02 7.04   2867    62
 Air Attack        CDF   ICS1  1    1     0    0    0.00 0.00   0       0
 Air Tanker        CDF   ICS1  1    528   0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
                               0    0     0    0    0.00 0.00   0       0
+-------------------------------------------------------------------------------+
```

Figure 21. ***Production rate➨Edit rates*** entry/edit screen.

LOCATIONS ➨ DISPATCH REQUIREMENTS

CFES2 simulates fires at the RFLs using the dispatch policies specified on ***Locations➨Dispatch requirements*** entry/edit screens (Figure 22). The display order for the records on this screen can be controlled via the ***Settings➨Sorting preferences*** menu choice. Descriptive information for each RFL includes number, description (up to 50 characters), FMAZ, control condition, fuel model, slope class and the percent of the FMAZ's fire load assigned with this RFL.

The firefighting resources that should be dispatched to an RFL are specified by category (engines, dozers, hand crews, etc.) and experience level, and by FDL. This allows the dispatch specifications for an RFL to reflect policies as nuanced such as "Send 6 engi nes, but be sure that at least two of them are from the CDF or USFS rather than local or volunteer firefighting organizations." This policy could be specified on this entry/edit screen as 2 `Primary` and 4 `Any` engines (assuming CDF and USFS engines had been assigned an experience level of `Primary` and local and volunteer engines of `Secondary`).

```
Enter ranger unit-unique RFL #
+------------------------------------------------------------------------------+
|                                                                              |
| RFL #25     RFL Descrip: AL01 BRIONES VALLEY                                 |
|                                                                              |
| Fmaz: SCUAL  Control condition: SCUAX1  RFL representation in FMAZ:  13.0%   |
|                                                                              |
| Fuel model: A3  Slope Class (+/-):  0-25 %                                   |
|                                                                              |
| EXPERIENCE +---- ENGINES ----+    +---- DOZERS -----+    +--- HANDCREWS ---+ |
|            | LOW MEDIUM HIGH |    | LOW MEDIUM HIGH |    | LOW MEDIUM HIGH | |
|   PRIMARY: | 4    6     8    |    | 1    1     2    |    | 0    0     0    | |
| SECONDARY: | 0    0     0    |    | 0    0     0    |    | 0    0     0    | |
|       ANY: | 0    0     0    |    | 0    0     0    |    | 0    0     0    | |
|            |                 |    |                 |    |                 | |
|            +-----------------+    +-----------------+    +-----------------+ |
|                                                                              |
| EXPERIENCE +-- HELICOPTERS --+    +-- AIR ATTACK ---+    +-- AIR TANKERS --+ |
|            | LOW MEDIUM HIGH |    | LOW MEDIUM HIGH |    | LOW MEDIUM HIGH | |
|   PRIMARY: | 0    1     1    |    | 0    0     0    |    | 0    2     2    | |
| SECONDARY: | 0    0     0    |    | 0    0     0    |    | 0    0     0    | |
|       ANY: | 0    0     0    |    | 0    0     0    |    | 0    0     0    | |
|            |                 |    |                 |    |                 | |
|            +-----------------+    +-----------------+    +-----------------+ |
+------------------------------------------------------------------------------+
```

Figure 22. ***Locations➨Dispatch requirements*** entry/edit screen.

To move among RFL records in the ***Locations➨Dispatch requirements*** entry/edit screen, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys. Paging down from the last record or pressing **<F6>** (New) will open a blank entry/edit screen into which information may be entered for a new RFL. This is the only screen in which new RFLs may be specified.

LOCATIONS ➨ RESPONSE TIMES

Response times (the time required for a particular resourc e to respond to a particular RFL) can be entered/edited by resource or by RFL. Invoke the ***Locations➨Response times*** menu choice to do the later. This calls up a pick list of RFLs in which you should highlight an RFL using the cursor movement keys, then sele ct it by pressing **<Enter>**. An entry/edit screen will then appear with three editable fields for each resource: resource identifier, the response time (in minutes), and mission (dispatch) cost (Figure 23). Specification of mission costs is optional, althoug h such costs are tallied for all firefighting resources dispatched to “contained” fires.

While the 8 character resource identifiers can be typed in, it is easier to select these from a pick list (accessed via **<F8>**). If a non-existent resource is specified, CFES2 will not permit any changes to data on the screen to be saved. To delete a response time, delete all characters in the resource identifier (e.g., via **<Ctrl><F7>**). As always, no changes are made to the data in memory until **<Ctrl><Enter>** is pressed.

```
Pick a Resource with <F8>.
+------------------------------------------------------------------------------+
|
|      Rfl: 1   AM01 PORT COSTA
|                                                              Response Mission
| Description                                         Resource Time    Cost
| CDF SONOMA S2 TANKER #1                             ALSRC110 25       $0.00
| CDF SONOMA S2 TANKER #2                             ALSRC220 25       $0.00
| CDF BELMONT ENGINE #1                               CZUB1175 64       $0.00
| CDF BELMONT ENGINE #2                               CZUB1176 75       $0.00
| CDF SKYLONDA ENGINE #2                              CZUB1260 88       $0.00
| CDF SKYLONDA ENGINE #1                              CZUB1277 88       $0.00
| CDF ALMA HELITACK                                   HWMAAC10 51       $0.00
| CDF NAPA ENGINE #2                                  LNUB2563 53       $0.00
| CDF NAPA ENGINE #1                                  LNUB2576 53       $0.00
| CDF GORDON VALLEY ENGINE #1                         LNUB3864 46       $0.00
| RODEO FIRE DISTRICT ENGINE #73                      RDOL0073 14       $0.00
| RODEO FIRE DISTRICT ENGINE #75                      RDOL0075 12       $0.00
| RODEO FIRE DISTRICT ENGINE #76                      RDOL0076 12       $0.00
| CDF MORGAN HILL ENGINE #2                           SCUB1165 105      $0.00
| CDF MORGAN HILL ENGINE #1                           SCUB1178 105      $0.00
| CDF SMITH CREEK ENGINE #1                           SCUB2163 105      $0.00
| CDF GLEN ELLEN ENGINE #1                            SCUB2174 55       $0.00
| CDF ALMADEN ENGINE #1                               SCUB2275 102      $0.00
+------------------------------------------------------------------------------+
```

Figure 23. ***Locations➨Response times*** entry/edit screen, partial view.

Use **<Up>** and **<Down>** to move among response records for an RFL (when there are more than 18 for an RFL, some of them will only be visible after scrolling down the screen using **<Down>** or applying the mouse to the slider on the right side of the screen). To move among RFLs, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys.

LOCATIONS ➨ TACTICS

Firefighting tactics are specified for RFLs, by FDL, via in ***Locations➨Tactics*** entry/edit screens (Figure 24). Some of the fields in this screen contain data that does not affect simulation outcomes, but which future versions of CFES2 may utilize.

```
Number of engines needed before second flank can be attacked at Low FDL.
+--------------------------------------------------------------------------+
|                                                                          |
|  RFL #25     RFL Descrip: AL01 BRIONES VALLEY                            |
|                                                                          |
|  Fmaz: SCUAL  Control condition: SCUAX1  RFL representation in FMAZ:  13.0%  |
|  +---------------------------------------------------------------------+ |
|  |        Engines   Engine     --- Type of Attack ---   Parallel    Initial |
|  | FDL   per flank   Mode      Head  Direct  Parallel  Offset (ft) Size (ac)|
|  | Low      3        Mobil     30     70      0          0          0.01 | |
|  | Medium   3        Mobil     0      100     0          0          0.01 | |
|  | High     3        Mobil     0      100     0          0          0.01 | |
|  +---------------------------------------------------------------------+ |
|                                  First Unit Delay (hr:min): 00:02        |
|                                 Fixed-wing return interval: 70           |
|                                 Helicopter return interval: 15           |
|                                                                          |
|  +---------------------------------------------------------------------+ |
|  | Out of service time (hrs:min) when resource is dispatched and:      | |
|  |          Engine      Dozer    Handcrew  Helicopter Air Attack Air Tanker|
|  | Unused    00:00      00:00     00:00     00:00      00:00      00:00 | |
|  | Contained 00:00      00:00     00:00     00:00      00:00      00:00 | |
|  | Escaped   03:00      03:00     03:00     03:00      03:00      03:00 | |
|  +---------------------------------------------------------------------+ |
+--------------------------------------------------------------------------+
```

Figure 24. ***Location➨Tactics*** entry/edit screen

Engines per flank refers to the number of engines that would be assigned to one flank before attack would be initiated on a second flank. The containment algo rithm currently relies on a simplifying assumption whereby it divides the productivity of all resources equally between two flanks, but this will likely be changed in future versions.

Engine mode can be `Mobile` attack or `Hoselay`. `Mobile` attack is typically associated with faster production rates in open, level or gently rolling terrain. Production rates must be specified for each mode/control condition combination referenced in a simulation.

The type of attack deployed at an RFL is specified by assigning pr obabilities to each of three types – *head*, *direct*, or *parallel*. For deterministic simulation of the type of attack employed at an RFL, assign a probability of 100 percent to one of the tactics and zero to the rest. Otherwise, assign nonzero percentages to two or three types, ensuring that these sum to 100. Head attack, usually used only with slow burning fires, means initiating fireline production at the head of the fire, direct attack means initiating fireline production at the tail of the fire. Parallel a ttack refers to a modified form of direct attack in which, instead of having "one foot in the green and one in the black", fireline is constructed at a specified offset distance to the free burning fire boundary, as is sometimes done in conjunction with th e setting of backfires.

The value entered in the *initial size* (i.e., at detection/dispatch) field is used to initiate the simulation of fire growth.

A *first unit delay* (in hours and minutes) may be assigned for an RFL to account for time spent by the fir st arriving resource to secure the area, gain access through locked gates, etc.

The fixed wing and helicopter *return intervals* are round trip times (in minutes) required for air tankers and helicopters after a drop to return to the source of more water or retardant, reload and return to the fire.

Out-of-service times affect the availability of firefighting resources on days with multiple fires. An out-of-service time for each type of resource must be specified for when it is dispatched but does not arrive in time to contribute to containment (i.e., unused), when it is dispatched and helps to contain a fire, and when it is dispatched to a fire that is ultimately declared to be an ESL fire.

Leaving any of these out-of-service times set to zero is likely to overestimate the actual availability of resources. Out-of-service times are in effect subsequent to fire ignition when the resource is either unused or the fire is declared and ESL fire, and subsequent to fire containment for those that are contained.

STATIONS ➨ ADD

Station names of up to 50 characters can be entered or viewed, one at a time, in the ***Stations➨Add*** entry/edit screen. Station names must be assigned from this list for all firefighting resources. While this data is currently purely descriptive, it may be used in subsequent versions of CFES2 to control the simulation of move-up and cover policies on days with multiple fires.

To move among station records, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys. Paging down from the last record or pressing **<F6>** (New) will open a blank entry/edit screen into which a new station name may be entered.

```
Enter the name of a fire station.
+--------------------------------------------------------------------------+
|                                                                          |
| Station Name: BEAR VALLEY                                                |
|                                                                          |
+--------------------------------------------------------------------------+
```

Figure 25. ***Stations ➨Add*** entry/edit screen

STATIONS ➨ EDIT

The ***Stations➨Edit*** entry/edit screen (Figure 26) allows for the editing of existing station names on a single screen. New station names can only be entered in the ***Stations➨Add*** entry/edit screen. To move among station names, use **<Up>**, **<Down>**, **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last).

```
Enter the name of a fire station.
          +----------------------------------------------------------□
          |
          |    Station Name                                          ┬
          |    ALMA                                                  |
          |    ALMADEN                                               |
          |    BEAR VALLEY                                           |
          |    BELMONT                                               |
 +--------|    BLANCHARD                                             |--------+
 |        |    BURRELL                                               |        |
 |        |    CASTLE ROCK                                           |        |
 |  Create|    CASTRO VALLEY                                         |        |
 |     Dat|    CATHEYS VALLEY                                        |        |
 |        |    CORRALITOS                                            |        |
 |        |    COYOTE                                                |        |
 |        |    DEL PUERTO                                            |        |
 |        |    EAST DIABLO                                           |        |
 |  Contro|    FELTON                                                |        |
 |    Prod|    GLEN ELLEN                                            |        |
 |        |    GORDON VALLEY                                         |        |
 |        |    HAYWARD                                               |        |
 |       R|    HOLLISTER                                             |        |
 |        |    HORNITOS                                              |        |
 +--------|    LIVERMORE                                             |--------+
  CFES2 ve+----------------------------------------------------------□/06/1997
```

Figure 26. ***Stations➨Edit*** screen

RESOURCE ➨ DESCRIPTIONS

Every resource available for firefighting in the Ranger Unit must be entered in a ***Resource➨Descriptions*** entry/edit screen (Figure 27). For each resource, enter a resource identifier (up to 8 characters), a resource description (up to 50 characters), station name, resource type, owner, ICS code, number of crew/operators, experience level, ability to be carried by helicopter, and out -of-service information. Station names can be selected from previously entered station names via **<F8>**.

```
Enter the resource identifier code
+----------------------------------------------------------------------------+
|                                                                            |
|    Resource ID Code: AAH0460C                                              |
|                                                                            |
|Resource Description: CDF HOLLISTER AIR ATTACK                              |
|                                                                            |
|             Station: HOLLISTER                                             |
|                                                                            |
| Resource Type: Air Attack   Owner: CDF    ICS Code: ICS1  Crew Size: 1     |
|                                                Out of service period       |
|    Experience: Primary                           #1               #2      |
|                                Sunday:  0:00 -  0:00     0:00 -  0:00     |
|                                Monday:  0:00 -  0:00     0:00 -  0:00     |
| Out of service dates         Tuesday:  0:00 -  0:00     0:00 -  0:00     |
|                             Wednesday:  0:00 -  0:00     0:00 -  0:00     |
| Period #1: 01/01-01/01        Thursday:  0:00 -  0:00     0:00 -  0:00     |
| Period #2: 01/01-01/01          Friday:  0:00 -  0:00     0:00 -  0:00     |
|                              Saturday:  0:00 -  0:00     0:00 -  0:00     |
|                                                                            |
| Can this resource be carried to the fireline by helicopter?  N             |
|                                                                            |
|       Unavailable due to maintenance/other (% of the year):  2             |
|                                                                            |
+----------------------------------------------------------------------------+
```

Figure 27. ***Resource➨Description*** entry/edit screen

The fields on this entry/edit screen for specifying out -of-service information allow for the specification of two periods in which out of weekly out -of-service times differ. These date ranges for each period should not span a year boundary (e.g., 11/1 - 2/28 would not be valid). A twenty-four hour (military time) format should be used to specify the daily out -of-service times for each day of the week for each period. These daily out -of-service periods should not span midnight.

In addition to the planned, specified period s of resource unavailability, a random unavailability to account for unscheduled maintenance, break -downs, operator illness, etc. can be specified as the percent of the time when the resource is likely to be unavailable outside of the normal out-of-service dates and times.

To move among existing resource description records, use **`<PgDn>`**, **`<PgUp>`**, **`<F9>`** (First), and **`<F10>`** (Last). Paging down from the last record or pressing **`<F6>`** (New) will open a blank entry/edit screen into which information may be entered for a new resource. This is the only screen in which new resources may be specified.

RESOURCE ➨ RESPONSE TIMES

Response times (the time required for a particular resource to respond to a particular RFL) can be entered/edited by resource or by RFL. Invoke the ***Resource➨Response times*** menu choice to do the former. This calls up a pick list of resources in which you should highlight a resource using the cursor movement keys, then select it by pressing **`<Enter>`**. An entry/edit screen will then appear with three edita ble fields for each resource: RFL number, the response time (in minutes), and mission (dispatch) cost (Figure 28).

Specification of mission costs is optional, although such costs are tallied for all firefighting resources dispatched to "contained" fires.

The RFL number can be typed in directly, but selecting it from a pick list (using **<F8>**) is easy if RFL records have already been entered. If a non -existent RFL is specified, CFES2 will not permit changes to be registered. To delete a response time, delete a ll characters in the RFL number field (**<Ctrl><F7>** will accomplish this in one keystroke). No changes are made to the data in memory until **<Ctrl><Enter>** is pressed.

Use **<Up>** and **<Down>** to move among response times for a resource. When there are more than 18, some will only be visible after scrolling down the screen using **<Down>** or applying the mouse to the slider on the right side of the screen. To move among resources, use the **<PgDn>**, **<PgUp>**, **<F9>** (First), and **<F10>** (Last) keys.

```
Pick an RFL with <F8>.
+--------------------------------------------------------------------------------+
¦
¦ Resource: ALHOC110 CDF HOLLISTER S2 TANKER #1
¦                                                            Response   Mission  ¦
¦ Description                                           Rfl    Time      Cost    ¦
¦ AL02 ALTAMONT PASS                                    2       34       $0.00   ¦
¦ AL03 MINES & DEL VALLEY ROADS                         3       31       $0.00   ¦
¦ AL04 INTERSTATE 5 & CROWS LANDING                     4       29       $0.00   ¦
¦ AM04 BOLINGER CANYON                                  7       37       $0.00   ¦
¦ AM05 HIGHWAY 580/ROWELL RANCH                         8       35       $0.00   ¦
¦ AM06 HIGHWAY 680/SUNOL                                9       37       $0.00   ¦
¦ AM07 CALAVERAS RESERVIOR-SOUTH                        10      28       $0.00   ¦
¦ AM08 SAN FELIPE & METCALF ROADS                       11      22       $0.00   ¦
¦ AM09 SANTA TERESA HILLS                               12      24       $0.00   ¦
¦ AM10 UVAS & OAK GLEN ROADS                            13      24       $0.00   ¦
¦ AM11 ROOP ROAD & COYOTE RESERVOIR                     14      22       $0.00   ¦
¦ BL02 MT LEWIS                                         16      33       $0.00   ¦
¦ BL03 SWEETWATER CDF STATION                           17      29       $0.00   ¦
¦ BL04 PACHECO PASS (SOUTH) & BELL STATION              18      14       $0.00   ¦
¦ FM01 GUADALOPE RESERVOIR                              21      28       $0.00   ¦
¦ GM01 HIGHWAY 9/REDWOOD GULCH                          22      27       $0.00   ¦
¦ GM02 HOLY CITY                                        23      30       $0.00   ¦
¦ AL05 ORESTIMBA NARROWS                                24      27       $0.00   ¦
+--------------------------------------------------------------------------------+
```

Figure 28. ***Resource➨Response times*** entry/edit screen

BEHAVIORS

Behaviors entry/edit screens (Figure 29) are used for entering the parameters for ROS and BI distributions defined for a weather station/ fuel model/ slope class/ herb class/ climate class combination. In most cases, these parameters will have been estimated using historical data processed through B EHAVE. A `B` in the herb class field (rather than an `A` or `P`) signifies that the record contains parameters for a BI rather than a ROS distribution.

For each of the three fire seasons defined by the dates entered on the ***Unitwide➨Seasons*** entry/edit screen, the 2 PM ROS (or BI) behavior parameters defined in Table 5 must be specified.

Table 5. Fire behavior parameters.

p(const)	The probability that ROS (or BI) will be small and adequately approximated by a constant, mean value, expressed as a fraction between 0 and 1
ROS	The mean ROS (or BI) for the "constant" case. This will almost always be small relative to the ROS values for the non-constant cases
Param1	The first (α) parameter of the ROS (or BI) beta distribution, this is usually a real number between 1 and 10
Param2	The second (β) parameter of the ROS (or BI) beta distribution, this is usually a real number between 1 and 10
ROS min	The left endpoint of the ROS (or BI) beta distribution, in chains per hour
ROS max	The right endpoint of the ROS (or BI) beta distribution, in chains per hour
L:W	The average length-to-width ratio for fires represented by this weather station/fuel combination

These parameters define the distribution of ROS or BI from which a random draw is used to generate a 2PM value for days on which fires "occur". This value is adjusted to reflect time of day using the diurnal adjustment coefficients specified in the bottom half of this entry/edit screen.

```
Official weather station number (up to 6 digits)
+------------------------------------------------------------------------------+
| +--------------------------------------------------------------------------+ |
| |              Weather Station: 43903   Fuel model: A3                     | |
| |    Slope Class (+/-): 26-40 %  Herb Class: B   Climate Class (+/-): 2    | |
| +--------------------------------------------------------------------------+ |
| +----------------------- DISTRIBUTIONAL PARAMETERS ------------------------+ |
| |           p(const)   ROS      Param1   Param2   ROS min  ROS max   L:W   | |
| |        Low  0.48    1.4       1.51     4.96      6         63      1.70  | |
| | Transition  0.48    2.4       1.33     4.13      9         54      1.70  | |
| |       High  0.15    3.7       2.05     4.94      11        73      1.80  | |
| +--------------------------------------------------------------------------+ |
| +-------------------- DIURNAL ADJUSTMENT COEFFICIENTS ---------------------+ |
| |       Standard Conditions                                                | |
| |                                                                          | |
| |  12a 0.08    08a 0.07    04p 0.83                                        | |
| |  01a 0.06    09a 0.21    05p 0.62                                        | |
| |  02a 0.06    10a 0.37    06p 0.39                                        | |
| |  03a 0.06    11a 0.60    07p 0.22                                        | |
| |  04a 0.06    12p 0.81    08p 0.14                                        | |
| |  05a 0.06    01p 0.95    09p 0.10                                        | |
| |  06a 0.05    02p 1.00    10p 0.08                                        | |
| |  07a 0.05    03p 0.95    11p 0.07                                        | |
| +--------------------------------------------------------------------------+ |
+------------------------------------------------------------------------------+
```

Figure 29. ***Behaviors*** entry/edit screen

CFES2 SIMULATION OUTPUTS

Some CFES2 simulation outputs can be viewed on screen as a simulation p roceeds, or after a simulation has completed or halted. Others can be written to comma -delimited ASCII files for importing into relational database or spreadsheet programs.

Tables

Invoking the ***Table*** menu choice on the CFES2 main menu results in the on -screen display of simulation results from the most recently initiated simulation. By default, a single year summary for the entire Ranger Unit is displayed. Pressing **`<F10>`** calls up the ***Output screen selection*** menu with the ***Pause*** and R***esume*** menu choices inactiv e.

Output ➨ Specify Outputs to Save

The ***Output ➨Specify outputs to save*** menu choice provides access to an entry/edit screen (Figure 9) for specifying which outputs to save in *.CS? output files.

Output ➨ Annual Stats

Invoking the ***Output➨Annual stats*** menu option writes out a summary (annual statistics) *.CS2 output file containing information on the number of contained and ESL fires, and acres burned by size class.

VI. Monitoring Simulation

Choosing the ***eXecute*** menu option on the CFES2 main menu initiates a s imulation using the input data currently in RAM. The simulation process can be monitored in a variety of real time display screens accessed via the ***Output screen selection*** menu.

ANNUAL SUMMARY

The upper half of the this display screen contains a table of t he number of acres burned by contained fires (either for the current year, or as expected values over multiple years) by FDL and user-specified size class. Also reported are total acres burned by size class, FDL, and in total, along with mean size of conta ined fires by FDL.

The lower half of the display screen contains the number of fires (either for a single year or as expected values over multiple years) by FDL and user -specified size class. Also reported are total numbers of contained fires by size clas s, total numbers of fires by FDL, and in total, along number of ESL fires by FDL.

The simulation year, amount of available system RAM, and the date of the last fire simulated are displayed at the bottom of this display screen.

EVENT LIST

Details of each simulated fire are displayed on the event list display screen, one line per fire. The color of the displayed text depends on the season of the year for the simulated fire: cyan for low, magenta for transition and red for high season.

The first six parameters displayed are date (mm/dd), time (hh:mm), FMAZ, RFL description (1st 12 characters), FDL (Lo/Me/Hi), and ROS (chains/hour).

The three slash delimited numbers which follow are the number of resources which arrived at the fire before its containment, the number of resources dispatched, and the number of resources with response records for this RFL.

The next three parameters are final size (acres), containment time (minutes) and containment costs (in dollars). Containment costs are computed as the sum of mission costs and per acre suppression costs.

The next two parameters indicate the tactic and strategy used to contain the fire: T for tail attack, H for head attack; D for direct attack and P for parallel (indirect attack).

The last parameter indicates how many times the simulation had to be run. If a fire is declared as an ESL due to fire over -running line-building forces, the simulation is re -run with the arrival time of the next arriving resource being substituted for all earlier resources (to ensure sufficient line-building capacity for safe initial attack). Thus fires that are barely contained may have been simulated more than once.

DISPATCH LIST

The dispatch list for each simulated fire can be viewed in a display screen during a simulation if dispatch list display is enabled via ***Settings ➨ Execution parameters*** menu choice prior to initiating a simulation. When this option is enabled, the dispatch list becomes the default display when simulation begins.

Entries (up to 66 resources) on a dispatch list will be displayed sorted by arrival time. The background color of dispatch list entries alternates by simulated fire (from cyan to brown) to facilitate detection of the first item in the list.

Displayed parameters include resource ID, response time (minutes), and production rate (chains per hour). Negative production rates represent production rate drop-offs for ground based resources or are part of the representation of an aerial drop of water or retardant as a 1-minute burst of fireline production.

An extra character following the resource ID facilitates debugging of CFES2 data sets. This character is a `D` for dispatch entries which represent production rate drop-offs, `S` for entries which represent resources diverted to structure protection, `B` for resources which are backed-up, and `C` for resources which are serving in a backup capacity.

Because this display screen updates rapidly on a fast computer, a dispatch list display delay can be specified via the ***Settings ➨ Execution parameters*** menu choice to make it easier to read the dispatch list display.

VII. Policy Analysis

CFES2 can be used to support operational decision making by simulating the potential effects of changes in:

- Availability of resources
- Stationing of resources
- Dispatch rules
- Criteria for setting fire dispatch level
- Staff schedules
- Deployment and line building tactics

CFES2 can also be used to support strategic planning with respect to:

- Vegetation management programs
- Development in the wildland-urban interface
- Reallocation of responsibilities among fire protection agencies
- Climatic change

COMPARISONS TO THE BASE CASE

The value of CFES2 for policy analysis depends on the quality of the "base case" developed to represent the current status of an initial attack system. Developing a good base case requires a significant investment of time in data collection, parameter estimation, and data entry; however, the information thus generated can have significant value apart from its use in CFES2.

The importance of the base case derives from the fact that CFES2 simulation outputs are often better interpreted by comparison to the base case than to recent history or historical averages. This is especially true when base case simulation outputs show differences from recent history – a situation which does not necessarily imply that the base case has been incorrectly specified. The base case is also important because most realistic policy changes constitute marginal departures from the status quo, and input data reflecting such a change can be quickly generated from a good base case.

In comparing simulation outputs, it is best to start by looking at differences in the distributions of: (1) the number of ESL fires per year; (2) the area burned per year (by size class); and (3) the number of fires per year (by size class). This information is displayed on-screen as simulations are run, and is written out to an annual summary (*.CS2) file suitable for further analysis using database or spreadsheet applications. The easiest comparisons to make are between expected values. It is almost as easy to compare values at a given percentile position in a distribution. (For example, analysts interested primarily in the effectiveness of initial attack in years with extreme fire weather or high numbers of fires will likely find comparisons of 90th or 95th percentile values useful.)

For many analysts, differences in the expected number of ESL fires per year will be of greater interest than differences in the expected number of acres burned by contained fires per year. This is because there is no upper bound on the area that may be burned by an ESL fire, or on the resulting damage. When the expected number of ESL fires is the same in different simulations, differences in the expected acres burned become more straightforward to assess, and a more important basis for comparisons.

Simulation outputs can be compared at the Ranger Unit level or at the FMAZ level. Making comparisons at the Ranger Unit level is easier in that it means tracking fewer statistics. On the other hand, simulation results at the Ranger Unit level may conceal as much as they reveal when FMAZs differ significantly in conditions, practices, or objectives (e.g., in the size or time limits defining ESL fires).

Comparisons can also be made at a fine spatial or temporal level using the simulation outputs written to event list (*.CS3) files. For example, it may sometimes be useful to summarize and compare simulation outputs for RFLs at which a disproportionate number of ESL fires are observed. It may also be useful to summarize and compare simulation results for all or part of a season, or even for particular days of the week (e.g., when considering possible changes in staff schedules).

This chapter outlines the procedures and simulation results for three example CFES2 analyses. Although these analyses are based on data from California's Nevada-Yuba-Placer (NEU) Ranger Unit (Figure 30), they were undertaken for purely pedagogical purposes, and any inferences drawn should not be construed as policy recommendations.

The first example concerns changing a "current practice" of diverting (from fireline production) first-arriving CDF or USFS fire engines to protect threatened structures. The second example looks at the contributions to initial attack made by resources not listed on "Schedule B", i.e., by resources which are not funded by the state for wildland fire protection (CDF Schedule A, USFS, local, and volunteer resources). The third example explores the impact of multiple fire starts on initial attack effectiveness.

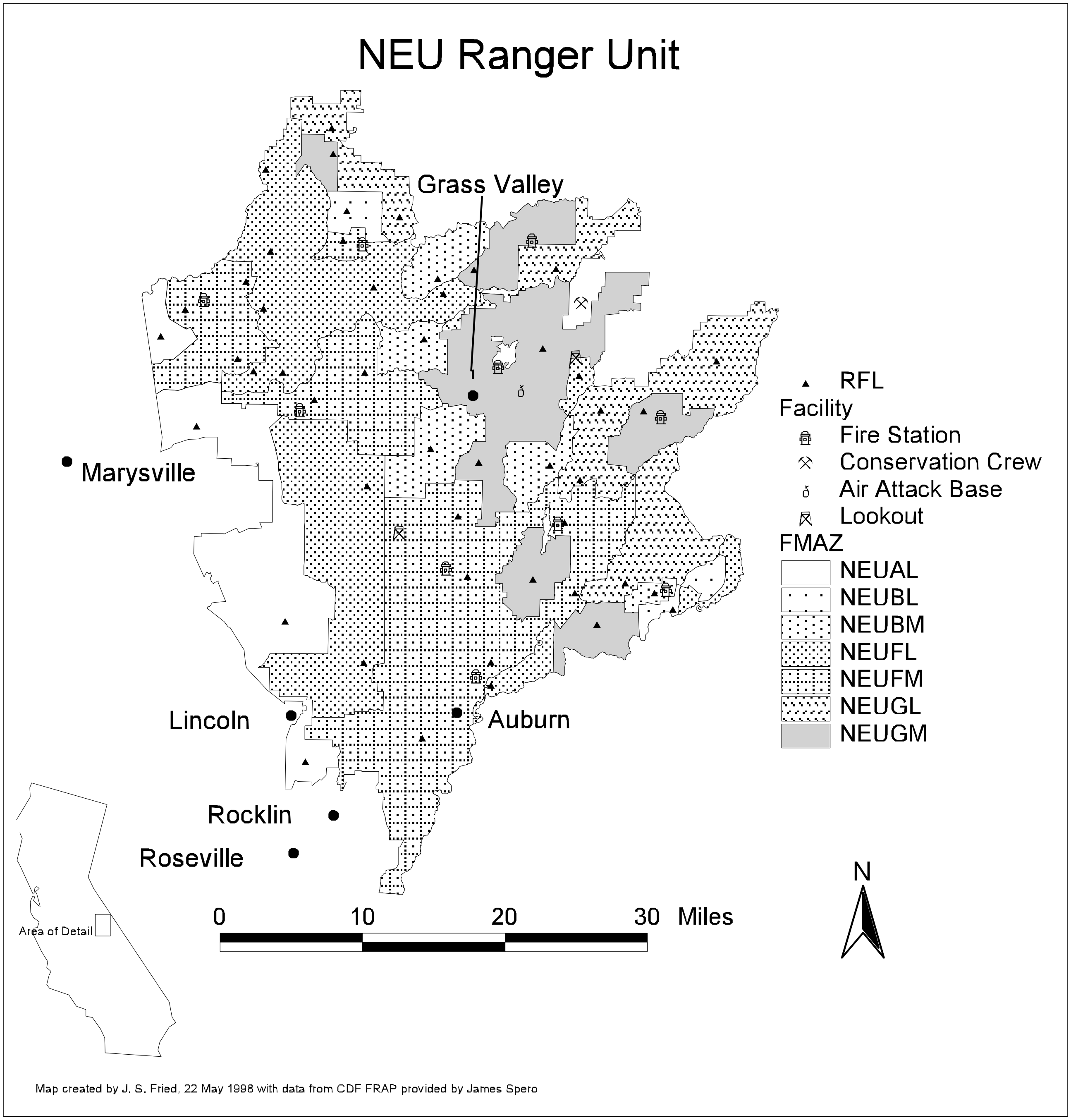


Figure 30. FMAZs, RFLs and stations for firefighting resources on the Nevada -Yuba-Placer (NEU) Ranger Unit.

EXAMPLE 1 – STRUCTURE PROTECTION

Assume that fire managers have expressed concern over the practice of diverting first arriving CDF and USFS engines to prote ct structures threatened by wildland -urban interface fires. They are concerned that this practice is resulting in larger, more damaging fires because it delays the onset of fireline construction.

CFES2 can address this issue from two rather different perspectives. First, assuming that the response by non-Schedule B resources could be sufficiently augmented to relieve the CDF from any responsibility for protecting structures, CFES2 could be used to assess the increase in initial attack effectiveness resulting from such an augmentation. On the other hand, the same simulation outputs could be used to characterize the cost of the current practice in terms of decreased initial attack effectiveness.

Procedures

The BASE.CF2 input data file contains a base case reflecting the "current" practice of using CDF and USFS engines to protect structures. The number of engines diverted depends on the FDL and on a FMAZ's population density. (For this analysis, engines designed for wildland firefighting [USFS and CDF Schedule B] are classified as "primary", all others as "secondary"). In low population density FMAZ's, one secondary engine is diverted to protect structures when the FDL is medium or high. With moderate or high population density, one secondary engine is diverted when the FDL is low, two secondary engines and one primary engine when the FDL is medium, and two secondary engines and two primary engines when the FDL is high.

To perform this analysis, the base case reflecting current practice input data was modified by eliminating structure protection requirements for primary resources, then saving the modified input data in a new file (NOSTR.CF2). This was accomplished by entering zeroes in the structure protection requirements fields for primary engines on the ***Backup and Structure Protection*** entry/edit screen for each FMAZ; had the objective been to eliminate all diversions (primary and secondary), this could have been accomplished by setting the ignore structure protection field to **Y** on the ***Simulation Parameters*** entry/edit screen.

BASE and NOSTR simulations were each run for 100 years, and annual summary (*.CS2), event list (*.CS3), and dispatch list (*.CS4) output data files were generated. The sizes of these files were 0.5, 8 and 100 Megabytes, respectively. These simulation outputs were loaded into a relational database (Paradox ™) for analysis using multi-table queries. Tabular output from selected queries was transferred to a spreadsheet (Excel ™), for preparation of the summary tables and figures shown below.

Results

Differences in the expected number of ESL fires between the BASE and NOSTR simulations were small, though the amount of difference varied among FMAZs (Table 6). For the entire Ranger Unit, the expected number of ESLs dropped from 1.4 in the BASE simulation to 1.0 in the NOSTR simulation. For the moderate population density, forested FMAZ (NEUGM), the expected number of ESL fires was significantly lower (0.1 vs. 0.6) in the NOSTR simulation, but was actually higher (0.5 vs. 0.2) for the moderate population density, oak woodland FMAZ (NEUFM).

At the Ranger Unit level, the expected acres burned annually by contained fires dropped from 1856 in the BASE simulation to 1590 in the NOSTR simulation (Table 7). Changes were small for most FMAZs, but were significant for NEUGM (89 acres) and for NEUFM

(56 acres). It is beyond the capacity of the model to assess the economic implications of the expected reduction in acres burned associated with the elimination of structure protection, or the impact on total structure losses of fewer acres being burned in contained fires.

Selected percentile values for the expected number of acres burned each year by contained fires (at the Ranger Unit level) are given in Table 8. Relative to the BASE simulation, the NOSTR simulation values were consistently lower, and with the differences accentuated at the higher percentiles that correspond to extreme fire years. Given that the number of expected ESL fires was also lower for the NOSTR simulation, such a drop in expected acres burned is unambiguous evidence of an increase in the effectiveness of initial attack.

In this example, one might suppose that eliminating the requirement to divert first-arriving resources to structure protection would shorten the response time for the first line-building resource. To explore this possibility, the simulation outputs written to the dispatch list (*.CS4) output files for the BASE and NOSTR simulations were queried to identify the response time of the first-arriving, line-building resources. Essentially, no change was observed (Figure 31). This might be interpreted as evidence that there is currently no shortage of rapidly responding resources in the Nevada-Yuba-Placer Ranger Unit.

Table 6. Expected values for the number of annual fires, by size cla ss, number of ESL fires, total number of fires, and containment success for “base case” (BASE) and “no structure protection” (NOSTR) simulations.

		Expected number of fires per year, by size class (acres)							
FMAZ	Simulation	0-0.25	0.25-20	20-50	50-100	100-300	ESL	Total	Contained
NEUAL	BASE	8.5	19.5	8.3	3.6	1.4	0.1	41.3	99.82%
	NOSTR	8.9	20.3	7.8	3.4	1.2	0.1	41.7	99.87%
		0-0.25	0.25-3	3-20	20-50	50-100	ESL		
NEUBL	BASE	2.3	2.3	1.0	0.2	0.0	0.0	6.0	99.89%
	NOSTR	2.4	2.3	1.0	0.2	0.0	0.0	5.9	99.93%
NEUBM	BASE	9.1	10.4	3.5	0.2	0.0	0.1	23.3	99.73%
	NOSTR	9.6	10.3	3.3	0.1	0.0	0.0	23.3	99.94%
NEUFL	BASE	97.8	20.6	9.9	0.9	0.0	0.2	129.4	99.86%
	NOSTR	99.6	18.9	9.9	0.8	0.0	0.2	129.3	99.85%
NEUFM	BASE	117.6	44.7	13.1	1.7	0.1	0.2	177.4	99.89%
	NOSTR	129.4	36.8	10.1	1.2	0.0	0.5	178.0	99.69%
		0-0.25	0.25-3	3-10	10-25	25-50	ESL		
NEUGL	BASE	12.3	16.0	8.8	3.1	0.5	0.2	40.9	99.53%
	NOSTR	12.2	16.5	8.7	2.9	0.4	0.1	40.8	99.68%
NEUGM	BASE	25.9	30.1	15.1	6.2	1.3	0.6	79.1	99.26%
	NOSTR	27.9	34.0	14.0	3.1	0.2	0.1	79.3	99.82%

Table 7. Expected values of the area burned by contained fires, by size class, mean fire size, and total area burned by contained fires for "base case" (BASE) and "no structure protection" (NOSTR) simulations.

		Expected acres burned per year, by size class (acres)						
FMAZ	Simulation	0-0.25	0.25-20	20-50	50-100	100-300	Mean Size	Total
NEUAL	BASE	0.7	151.5	265.8	250.0	195.3	20.9	863.3
	NOSTR	0.7	156.2	250.6	237.8	168.9	19.5	814.2
		0-0.25	0.25-3	3-20	20-50	50-100		
NEUBL	BASE	0.2	1.8	9.3	6.3	1.6	3.4	19.3
	NOSTR	0.2	1.8	8.6	6.1	2.1	3.1	18.8
NEUBM	BASE	1.0	7.4	24.6	5.1	2.2	1.7	40.3
	NOSTR	1.1	7.5	21.2	1.5	0.2	1.4	31.6
NEUFL	BASE	8.6	19.9	76.3	23.3	1.8	1.0	129.9
	NOSTR	8.9	19.4	75.6	22.2	1.3	1.0	127.4
NEUFM	BASE	9.0	33.3	106.7	48.9	9.4	1.2	207.4
	NOSTR	9.5	26.0	80.1	33.7	2.4	0.9	151.7
		0-0.25	0.25-3	3-10	10-25	25-50		
NEUGL	BASE	1.1	18.8	50.1	45.2	15.9	3.2	131.1
	NOSTR	1.1	19.5	48.6	43.0	14.3	3.1	126.5
NEUGM	BASE	2.1	35.1	84.9	93.3	41.8	3.3	257.3
	NOSTR	2.4	40.1	75.3	44.2	6.0	2.1	168.0

Table 8. Acres burned at selected percentiles of the distributions of acres burned by contained fires in the NEUAL FMAZ for "base case" (BASE) and "no structure protection" (NOSTR) simulations.

Percentile	BASE	NOSTR
1st	335	319
5th	464	438
10th	542	505
25th	679	635
50th	835	798
75th	1026	965
90th	1220	1149
95th	1340	1290
99th	1598	1470

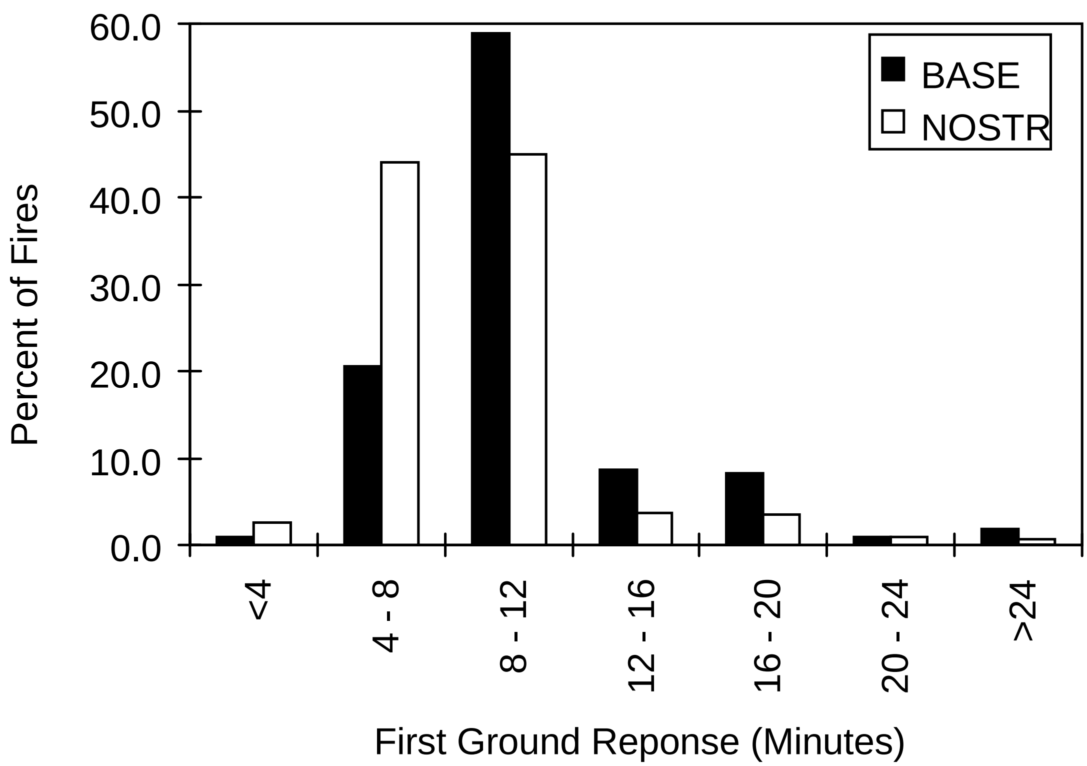


Figure 31. Relative frequency histograms for response time of first -arriving resource which produces fireline, for each of 50,000+ fires (over 100 years) simulated for "base case" (BASE) and "no structure protection" (NOSTR) simulations.

EXAMPLE 2 –SCHEDULE B RESOURCES ONLY

In California, as elsewhere, local and volunteer resources play an important supporting role to the state-funded wildland resources with primary responsibility for initial attack. Information on the contributions of such "non-Schedule B" resources to initial attack effectiveness is generally lacking, despite its potential value to decision makers allocating public funds or making operational decisions relating to the stationing of firefighting resources.

Procedures

The BASE.CF2 base case input data file was modified specify the dispatch of CDF Schedule B wildland resources only, and the results saved in a new file (BONLY.CF2). This could have been done either by: (1) deleting all non-Schedule B resources (by pressing **`<Ctrl><F7>`** for each such ***Resource Description*** entry/edit screen corresponding to a non-Schedule B resource); or (2) "removing" non-Schedule B resources by changing their Out-of-service Periods to run from January 1 through December 31.

BASE and BONLY simulations were each run for 100 years, and annual summary (*.CS2), event list (*.CS3), and dispatch list (*.CS4) output data files were generated. The *.CS2 data was loaded into a database (Microsoft Access 95 ™) for analysis. A simple query was used to eliminate records with FDL-specific totals from calculation of the expected values (Figure 32 ~ Note the "WHERE FDL=4" clause, the value 4 indicating a summary record with annual totals across FDLs). The query result thus generated contained expected acres burned and number of fires per year by size class, average fire size, and expected number of ESL fires, for each FMAZ. This query result was exported to a spreadsheet (Microsoft Excel™) to calculate containment success and total area burned per year by contained fires (Tables 9 and 10).

```
SELECT DISTINCTROW NEUBONLYCS2.FmazCode,
Avg(NEUBONLYCS2.NumContainedFires1) AS AvgOfNumContainedFires1,
Avg(NEUBONLYCS2.NumContainedFires2) AS AvgOfNumContainedFires2,
Avg(NEUBONLYCS2.NumContainedFires3) AS AvgOfNumContainedFires3,
Avg(NEUBONLYCS2.NumContainedFires4) AS AvgOfNumContainedFires4,
Avg(NEUBONLYCS2.NumContainedFires5) AS AvgOfNumContainedFires5,
Avg(NEUBONLYCS2.NumESLs) AS AvgOfNumESLs, Avg(NEUBONLYCS2.NumTot)
AS AvgOfNumTot, Avg(NEUBONLYCS2.AreaBurned1) AS AvgOfAreaBurned1,
Avg(NEUBONLYCS2.AreaBurned2) AS AvgOfAreaBurned2,
Avg(NEUBONLYCS2.AreaBurned3) AS AvgOfAreaBurned3,
Avg(NEUBONLYCS2.AreaBurned4) AS AvgOfAreaBurned4,
Avg(NEUBONLYCS2.AreaBurned5) AS AvgOfAreaBurned5,
Avg(NEUBONLYCS2.AvgFireSize) AS AvgOfAvgFireSize,
Avg(NEUBONLYCS2.AreaBurnedTot) AS AvgOfAreaBurnedTot
FROM NEUBONLYCS2
WHERE (((NEUBONLYCS2.FDLSummaryLevel)=4))
GROUP BY NEUBONLYCS2.FmazCode;
```

Figure 32. SQL (Standard Query Language) query to summarize simulation outputs in an annual summary (*.CS2) output file, constructed within Microsoft Access 95 ™ using the native Access query interface.

In the first example, specified percentile points on distributions for fire size were used to shed some light on initial attack success in extreme fire years. Additional insight into the effects of a change in the initial attack system can be obtained from examination of histograms of expected numbers of ESL fires or acres burned for different simulations. Histograms of this sort were created from the annual summary (*.CS2) output files generated by the BASE and BONLY simulations via spreadsheet software (Microsoft Excel 95™, using the frequency calculation capability of its Data Analysis/Histogram module and the multi-column plotting capability of its Chart module) (Figure 33). Producing these histograms took approximately 15 hours, including simulation, database and spreadsheet manipulation of data, and preparation of graphs; however, for comparisons which will be made frequently, up-front investment in the design of application scripts (e.g., Microsoft's Visual Basic™ for Applications, SAS™, or SPSS™) could reduce this time requirement by an order of magnitude.

Results

Despite elimination of more than one-third of the resources (24 of 69) deployable on the Ranger Unit, expected containment success (percent of fires prevented from exceeding simulation limits) remained very high (>98% in all cases) (Tables 9 and 10). The magnitude of the change in containment success appears to vary among FMAZs. However, with a fire load of several hundred fires each year and given the downside risk of fatalities or large property losses when large fires occur, the difference between a containment success of 99.82% and 98.28% for the BASE and BONLY simulations in NEUAL is <u>not</u> trivial.

The largest difference in the expected number of ESL fires was projected for the low population density grassland FMAZ (NEUAL). With non -Schedule B resources available, 0.1 ESL fires would be expected per year in this FMAZ (i.e., an ESL fire would be expected about once in ten years) Without the non -Schedule B resources, however, the expected of number ESL fires per year increased to 0.7 (i.e., about seven ESL fires would be expected in ten years). A smaller increase in expected ESL fires was observed for the medium population density, forested FMAZ (NEUGM), from 0.6 to 1.0 per year. Although this absolute increase in expected ESLs is smaller, fire planners might find it of g reater concern because of the higher population density in that FMAZ.

Most of the change in expected acres burned by contained fires due to the elimination of the non-Schedule B resources was projected for the low population density grassland FMAZ (NEUAL). Whether or not this would pose a serious problem would depend on the fire management objectives for that FMAZ. The increased area burned due to the FMAZ's higher number of expected ESL fires might well exceed the projected 700 acres increase in acres burned by contained fires. Furthermore, grassland acres that burn in contained fires might be less likely to entail significant property damage, and might reduce the expected number of ESL fires in the future by contributing towards a mosaic of vegetation type s and/or age classes.

The histograms in Figure 33 provide an alternative, and perhaps more complete way to visualize these outcomes. For example, in NEUAL, the 7 in 10 chance of an ESL in a given year without the non-Schedule B resources can be further ref ined to a 38% chance of one, a 12% chance of two, a 2% chance of three and a 1% chance of four ESLs in any one year. Further, the chance of having no ESL fires drops from 90% to fewer than 50% when these resources are eliminated.

These simulation results s uggest that non-Schedule B resources contribute to initial attack effectiveness in the NEUAL and NEUGM FMAZs, but have little impact elsewhere in the Ranger Unit. However, the elimination of these resources could increase the frequency with which the Sched ule B resources are dispatched, ultimately resulting in higher overtime costs, or reducing opportunities to deploy Schedule B resources for prescribed burning. Further examination of these issues could be conducted using the dispatch information stored in the dispatch list (*.CS4) output file.

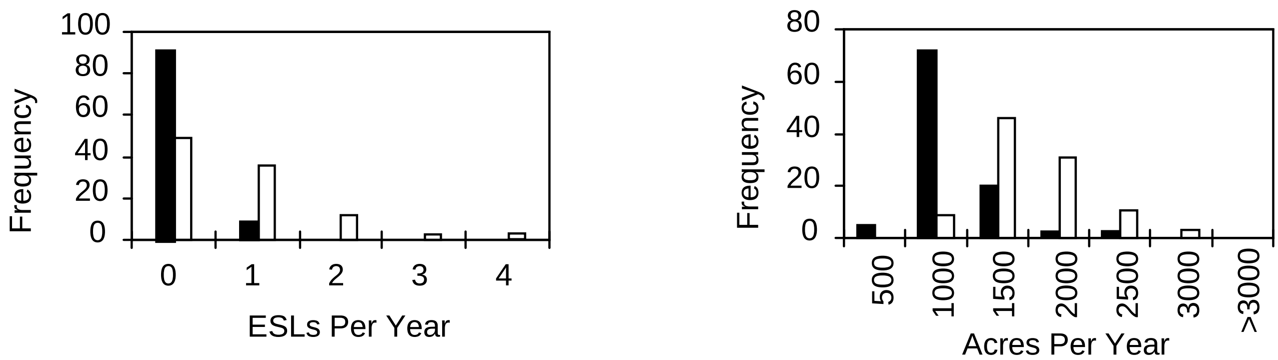
Table 9. Expected values for the number of fires, by size class, number of ESL fires, total number of fires, and containment success for "base case" (BASE) and "Schedule B only" (BONLY) simulations.

FMAZ	Simulation	Expected number of fires per year, by size class (acres)						Total	Contained
		0-0.25	0.25-20	20-50	50-100	100-300	ESL		
NEUAL	BASE	8.5	19.5	8.3	3.6	1.4	0.1	41.3	99.82%
	BONLY	6.4	16.3	8.3	5.5	4.7	0.7	41.9	98.28%
		0-0.25	0.25-3	3-20	20-50	50-100	ESL		
NEUBL	BASE	2.3	2.3	1.0	0.2	0.0	0.0	6.0	99.89%
	BONLY	2.1	2.4	1.2	0.2	0.0	0.0	6.0	99.60%
NEUBM	BASE	9.1	10.4	3.5	0.2	0.0	0.1	23.3	99.73%
	BONLY	8.8	10.7	4.0	0.2	0.0	0.1	23.9	99.77%
NEUFL	BASE	97.8	20.6	9.9	0.9	0.0	0.2	129.4	99.86%
	BONLY	81.3	36.0	12.0	1.3	0.1	0.2	131.0	99.84%
NEUFM	BASE	117.6	44.7	13.1	1.7	0.1	0.2	177.4	99.89%
	BONLY	118.0	45.0	13.3	1.9	0.2	0.5	178.8	99.74%
		0-0.25	0.25-3	3-10	10-25	25-50	ESL		
NEUGL	BASE	12.3	16.0	8.8	3.1	0.5	0.2	40.9	99.53%
	BONLY	12.2	16.2	8.9	2.9	0.5	0.3	41.0	99.24%
NEUGM	BASE	25.9	30.1	15.1	6.2	1.3	0.6	79.1	99.26%
	BONLY	25.7	30.7	15.2	6.1	1.6	1.0	80.3	98.78%

Table 10. Expected values of the area burned by contained fires, by size class, mean fire size, and total area burned by contained fires for "base c ase" (BASE) and "Schedule B only" (BONLY) simulations.

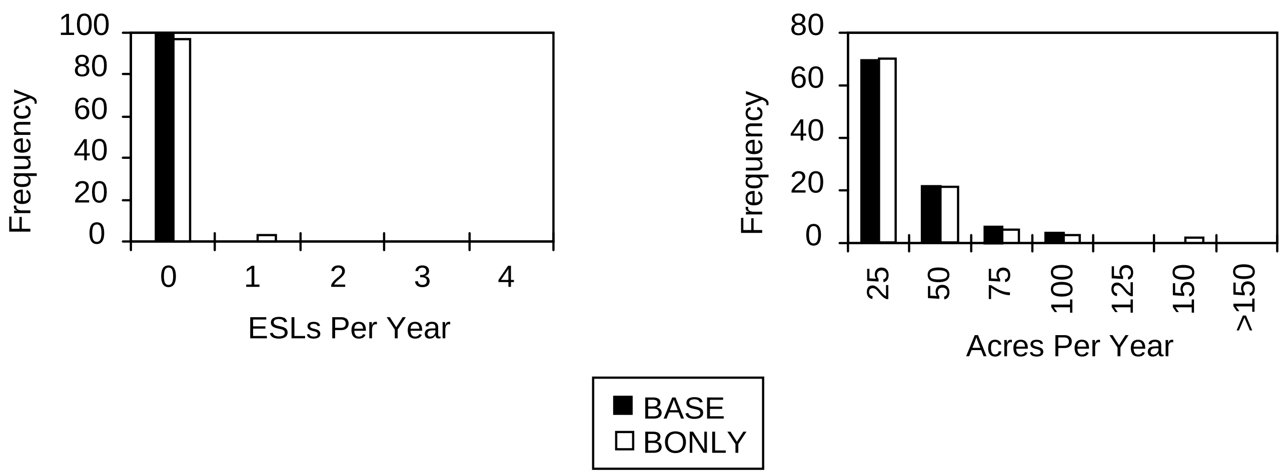
FMAZ	Simulation	Expected acres burned per year, by size class (acres)					Average	Total
		0-0.25	0.25-20	20-50	50-100	100-300		
NEUAL	BASE	0.7	151.5	265.8	250.0	195.3	20.9	863.3
	BONLY	0.8	118.3	271.9	390.7	756.9	37.3	1538.5
		0-0.25	0.25-3	3-20	20-50	50-100		
NEUBL	BASE	0.2	1.8	9.3	6.3	1.6	3.4	19.3
	BONLY	0.2	2.0	10.6	6.5	1.7	3.5	21.0
NEUBM	BASE	1.0	7.4	24.6	5.1	2.2	1.7	40.3
	BONLY	0.9	7.9	31.5	6.5	1.8	2.0	48.6
NEUFL	BASE	8.6	19.9	76.3	23.3	1.8	1.0	129.9
	BONLY	8.6	25.0	96.6	38.5	3.7	1.3	172.4
NEUFM	BASE	9.0	33.3	106.7	48.9	9.4	1.2	207.4
	BONLY	9.3	34.1	106.8	54.1	12.8	1.2	217.2
		0-0.25	0.25-3	3-10	10-25	25-50		
NEUGL	BASE	1.1	18.8	50.1	45.2	15.9	3.2	131.1
	BONLY	1.0	19.0	49.6	41.9	17.9	3.2	129.3
NEUGM	BASE	2.1	35.1	84.9	93.3	41.8	3.3	257.3
	BONLY	2.1	36.6	86.5	93.3	53.1	3.4	271.7

NEUAL



Frequency
100
80
60
40
20
0
0
1
2
3
4
ESLs Per Year
Frequency
80
60
40
20
0
500
1000
1500
2000
2500
3000
>3000
Acres Per Year

NEUBL



Frequency
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60
40
20
0
0
1
2
3
4
ESLs Per Year
Frequency
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40
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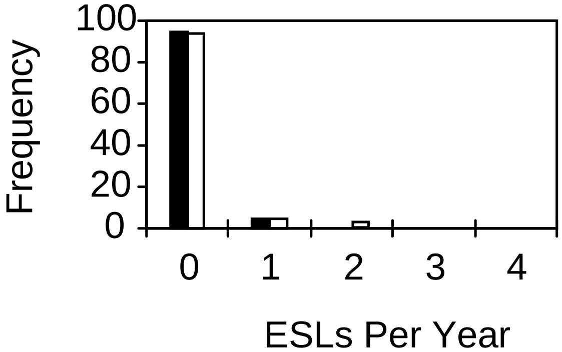
0
25
50
75
100
125
150
>150
Acres Per Year
BASE
BONLY

NEUBM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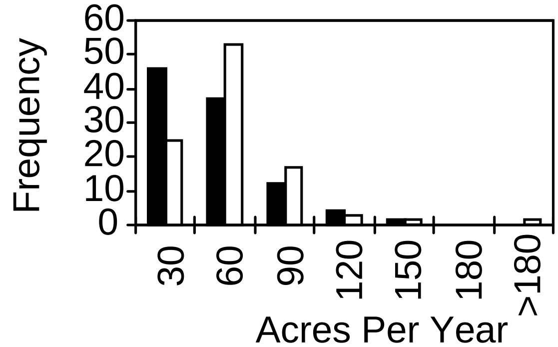
1
2
3
4
ESLs Per Year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10
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30
60
90
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150
180
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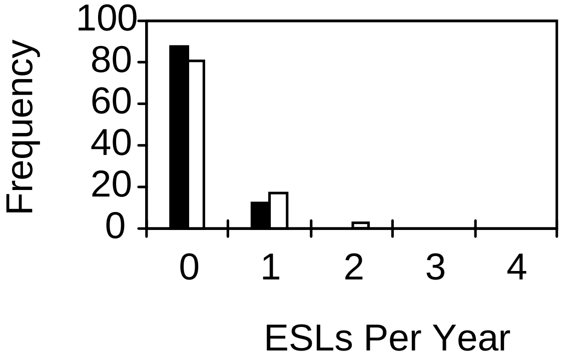
Acres Per Year

NEUFL


Frequency
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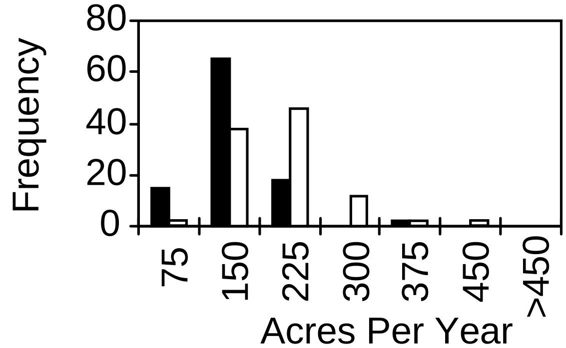
40
20
0
0
1
2
3
4
ESLs Per Year


Frequency
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20
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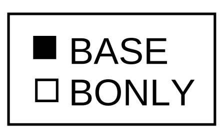
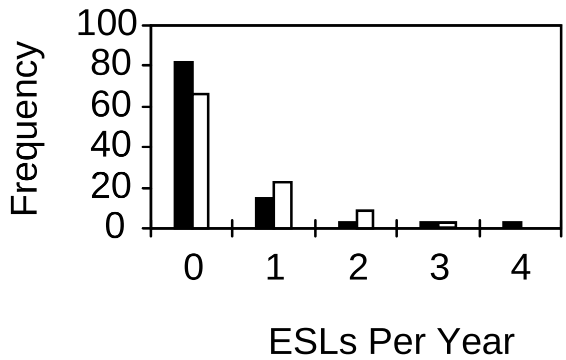
75
150
225
300
375
450
>450
Acres Per Year


BASE
BONLY

NEUFM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1
2
3
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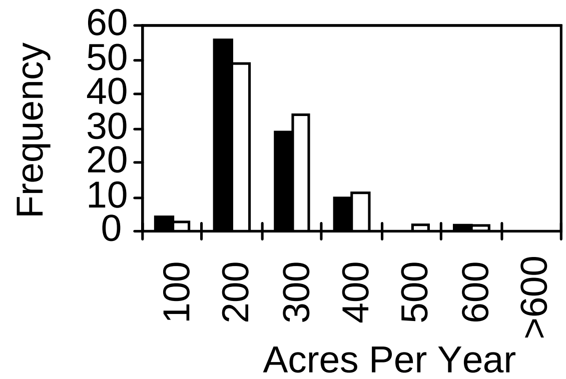
ESLs Per Year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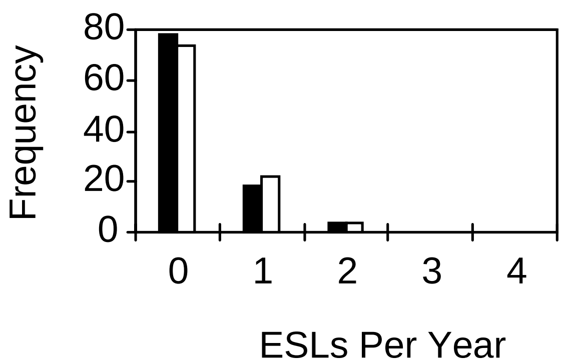
Acres Per Year

NEUGL


Frequency
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40
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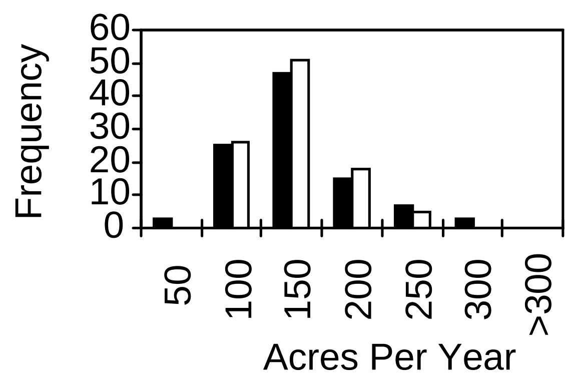
0
1
2
3
4
ESLs Per Year


Frequency
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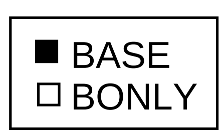
0
50
100
150
200
250
300
>300
Acres Per Year


BASE
BONLY

NEUGM

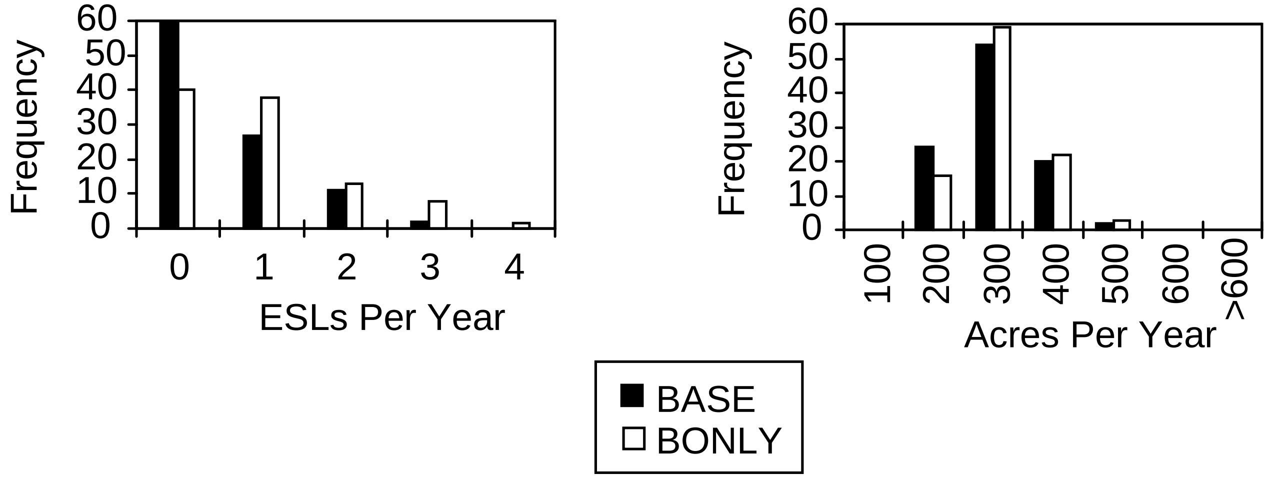


Figure 33. Relative frequency histograms of number of ESL fires per year and total acres burned in contained fires per year, by FMAZ, for “base case” (BASE) and a “Schedule B only” (BONLY) simulations.

EXAMPLE 3 - EFFECTS OF MULTIPLE FIRES

One of the reasons for commissioning CFES2 was interest on the part of fire planners in being able to explicitly address the impacts of multiple fire starts on the availability of resources for dispatch. It is widely believed that multiple fire or "draw -down" situations result in many fires escaping initial attack. The relatively short period for which historical fire data is available for most Ranger Units makes it difficult to reach definitive conclusions about this hypothesis, but an event -based simulation model like CFES2 provides valuable insight into the problem.

Procedures

The simulation outputs written to event list (*.CS3) output files provide the basis for conducting an analysis of the multiple fire problem. These outputs include start times, containment times, and containment outcomes. A simple indicator of the severity of multiple-fire problem for any given fire is the total number of fires occurring on the same day. Referred to previously as "multiplicity", this value figures prominently in CFES2's Occurrence module. Using a database (Paradox ™) the data in the event list (*.CS3) output file from the BASE simulation were queried to determine multiplicity for each simulated fire. These values were then examined to see if there was an association between ESL fires and days with high multiplicity.

Results

Although a clear relationship between ESL fires and high multiplicity is not apparent in the available historical records for the Nevada -Yuba-Placer Range Unit (1986 -1994), a relationship is observable in the simulation outputs from the BASE simulation (Table 11).

The validity of this inference is supported by the similarity of the historical and simulated multiplicity values for the NEU Ranger Unit (Figure 34). As expected, the simulation results closely track the historical values up to multiplicity=11, but also include some fires with higher multiplicity.

Table 11. Mean multiplicity for all fires, by FMAZ and containment outcome, for the historical period 1986 -1994 and the "base case" (BASE) simulation.

	1986-1994		BASE	
FMAZ	ESL	Contained	ESL	Contained
NEUAL	2.5	3.7	6.3	4.4
NEUBL		3.2	6.5	4.6
NEUBM		3.3		4.6
NEUFL	3.1	3.7		4.4
NEUFM	4.0	3.7	7.8	4.5
NEUGL		4.6	6.6	4.5
NEUGM	5.7	3.7	6.7	4.5

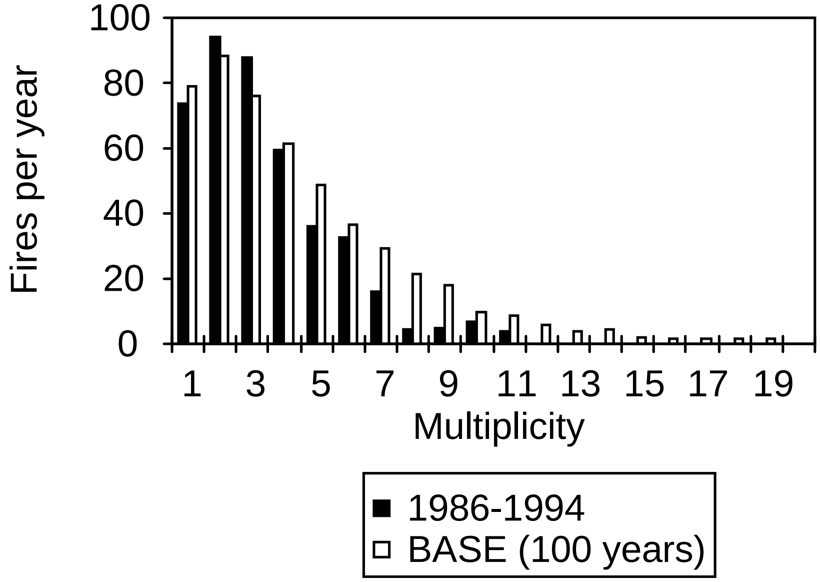


Figure 34. Multiplicity for all fires in the historical period 1986 -1994 and the "base case" (BASE) simulation.

Appendix I: Export File Formats

The tables that follow document the format of the comma and quote deli mited ASCII export *.CD? (? = 0,1… 9) files produced by CFES2 version 2.0. All data are separated by commas. All data stored in string (text) variables appear in double quotes. Consecutive double quotes indicate a blank text field. These files can be easil y imported into most database and spreadsheet packages. Date and time fields may require special handling.

CD0 Files—Ranger Unit Data

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
Number[OfFmazs]	Integer	Number of Fmazs in data set
Number[OfCCs]	Integer	Number of CCs in data set
Number[OfRfls]	Integer	Number of Rfls in data set
Number[OfPRates]	Integer	Number of PRates in data set
Number[OfResources]	Integer	Number of Resources in data set
Number[OfResponses]	Integer	Number of Responses in data set
Number[OfStations]	Integer	Number of Stations in data set
Number[OfBehaviors]	Integer	Number of Behaviors in data set
SeasonBreakMap	array[1..5] of date	Date breakpoints demarcating low, transition and high seasons
OccModDistType	array[1..3] of DistType	Names of fireday, multiplicity and time of day distributions
OccModParam	array[1..3, fireday..tod, 1..3] of real	For each season, for each distribution, up to three parameters of type real
DateStamp	Date	Date file last saved
Dawn, Dusk	array[low.. high] of time	Time of dawn and dusk for each season
TodEndPoint	array[low.. high] of byte	Time of day distribution endpoint, by season
OutputSizeClass	array[1..4] of real	Upper bounds of first 4 unitwide output size classes
SimulationSizeLimit	real	Simulation size limit (unitwide) for use as upper bound of fifth output size class

CD1 Files—Ranger Unit Labels

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
CfesVersionNumber	Real	Version of CFES used to export file
RuName	string(50)	Name of ranger unit
SimulationCoordinator	string(50)	Name of CFES coordinator
Assistant1	string(50)	Name of first assistant to CFES coordinator
Assistant2	string(50)	Name of second assistant to CFES coordinator
RUCode	string(3)	3 letter ranger unit code
SimulationLabel	string(240)	A label describing the simulation data set
SimulationCode	string(27)	Short label to appear with simulation output

CD2 Files—FMAZ

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
FMAZName	string(50)	Description of FMAZ
FMAZCode	string(5)	5 letter FMAZ identifier
SimulationSizeLimit	real	Simulation size limit for FMAZ
SimulationTimeLimit	time	Simulation time limit for FMAZ
DiLMbreak, DiMHbreak	integer	Dispatch index breakpoints between low and medium and between medium and high
HabitationDensity	string	Level of population density (low, medium, high)
FMAZPercentRep	real	Percent of fires in ranger unit in this FMAZ
OutputSizeClass	array[1..4] of real	Upper bounds of first four output size classes
AvgCostPerAcSzCl	array[1..2, 1..14] of real	For 14 average per acre cost classes, upper bound (acres) and cost (dollars)
BackupSpecification	array[1..8] of	
PrimaryRes.Category	special	Category of the resource to be backed up
PrimaryRes.Experience	special	Experience level of the resource to be backed up

BackupRes.Category	special	Category of the backup resource
BackupRes.Experience	special	Experience level of the backup resource
BackupResNeed	special	Desired or Required
BackupResProduces	boolean	Does the backup resource produce line
EliminatesDropOff	boolean	Does the backup resource eliminate dropoff
StructureProtection	array[1..4] of	
Resource	special	Type of resource needed for structure protection
Experience	special	Experience level of resource
Quantity	array [1..3] of integer	Number of resource type needed for low, medium and high dispatch level
AvgParcelSize	real	Average parcel size
RosBehaveKey		
HerbClass	char	Annual (A) or Perennial (P)
ClimateClass	byte	1-4
WxStation	integer	AFFIRMS weather station number
Slope	byte	Slope class (1-5)
FuelModel	string(2)	Letter-number modified NFDRS fuel model
DiBehaveKey		
HerbClass	char	Annual (A) or Perennial (P) or Burning Index (B)
ClimateClass	byte	1-4
WxStation	integer	AFFIRMS weather station number
Slope	byte	Slope class (1-5)
FuelModel	string(2)	Letter-number modified NFDRS fuel model

CD3 FILES—CONTROL CONDITION

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
ControlCondition	string(6)	Control condition code
CcDescrip	string(240)	Control condition description

CD4 FILES—RFL

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
Fmaz	string(5)	FMAZ in which RFL located
RflNum	integer	RFL number
RflDescrip	string(50)	Description of the RFL
RflCC	string(6)	Control condition applicable to the RFL
RflPercentRep	real	Percent of fires in the FMAZ represented by RFL
WhatToSend	array[low.. high, engine ..airtanker, primary.. any] of byte	How many resources to send by FDL, resource type and experience level
EnginesNeededForHoselayFlank	array[low.. high] of byte	Number of engines to commit to flank 1 before starting attack on flank 2
FixedWingReturnInterval	byte	Number of minutes needed for air tanker roundtrip and reload
RotaryWingReturnInterval	byte	Number of minutes needed for helicopter roundtrip and reload
FuelModel	string(2)	Fuel model can override FMAZ fuel model choice
Slope	byte	Slope class 1-4 (can override FMAZ slope choice)
Tactic	array[1..3, low..high] of byte	Percent of fires fought with Head, Direct and Parallel attack, by FDL
LineBuildOffset	array[low.. high] of integer	Number of feet of offset, by FDL

FirstUnitDelay	time	Time required for first arriving resource to perform non-line-building activities
ChopperSavings	time	Arrival time saved, per carried resource, by presence of chopper
UnAvail	array[1..3, engine.. airtanker] of time	Unavailability time for each resource type by situation (1=dispatched but not used; 2=used but no escape; 3=used and escape)
InitialSizeAc	array[low.. high] of real	Size at report time by FDL
EngineMode	array[low.. high] of special	Mode of attack (hoselay, mobile attack) used by engines, by FDL

CD5 FILES—PRODUCTION RATE

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
CcCode	string(6)	Control condition code
Resource.Category	special	e.g., engine, dozer
Resource.Owner	special	e.g., CDF, USFS, local. Volunteer
Resource.Production	special	e.g., hoselay/mobile, helicopter crew/drop
ICSidentifier	special	ICS1-3
CrewSize	byte	Number of people assigned to this resource
Feet	integer	Length for which construction times estimated
BestTime	integer	Optimistic time to complete line
WorstTime	integer	Pessimistic time to complete line
alpha	real	first parameter of the beta distribution
beta	real	second parameters of the beta distribution
DropDistance	integer	Distance, in feet, at which drop-off effect begins
TimeForNext	integer	Time, in minutes, to complete the next X feet

CD6 FILES — RESOURCE

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
ResourceID	string(8)	Resource identifier
ResourceDescription	string(50)	Description of resource
Station	string(50)	Name of station where resource is based
Resource.Category	special	e.g., engine, dozer
Resource.Owner	special	e.g., CDF, USFS, local. Volunteer
ICSidentifier	special	ICS1-3
CrewSize	byte	Number of people assigned to this resource
Experience	special	primary or secondary
DownDates	array[1..2, 1..2] of date	Two ranges of dates during which resource is not available
Unstaffed	array[Sun.. Sat,1..2, 1..2] of time	Start and finish times for 2 periods per day for seven days, during which resource is not available
DownRandom	real	Percent of time that resource is randomly unavailable
CanResourceBeChoppered	boolean	Can this resource be conveyed by a helicopter

CD7 FILES—RESPONSE

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
ResourceID	string(8)	Resource identifier
Rfl	integer	RFL number
ResponseTime	integer	Number of minutes required to respond to fire at that RFL
MissionCost	real	Dollars in expense incurred by dispatch of the resource to this RFL

CD8 FILES—STATION

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
StationName	string(50)	Name of station

CD9 Files — Behavior

Variable	Type	Description
SourceFile	string	Name of export file
Today	Date	Date file exported
BehaveKey		
HerbClass	char	Annual (A) or Perennial (P) or Burning Index (B)
ClimateClass	byte	1-4
WxStation	integer	AFFIRMS weather station number
Slope	byte	Slope class (1-5)
FuelModel	string(2)	Letter-number modified NFDRS fuel model
BehaviorDist	array[low.. high] of special	
BernoulliParameter	real	Probability of low (constant) behavior value
BernoulliRos2pm	real	Average value of low behavior
BetaParam1	real	1st beta parameter for behavior distribution
BetaParam2	real	2nd beta parameter for behavior distribution
2pmMin	real	Left endpoint of behavior distribution
2pmMax	real	Right endpoint of behavior distribution
DiurnalAdjustment	array[1..2, 1..24] of real	Dirunal adjustment parameters, by hour of the day, for normal and east wind conditions
LWratio	array[low.. high] of real	Length-to-width ratio for fires, by season

Appendix II: Output File Formats

The tables that follow document the format of the comma and quote delimited ASCII simulation output *.CS? (? = K, 2, 3, or 4) output files produced by CFES2 version 2.0. All data are separated by commas. All data stored in string (text) variables appear in quotes. Consecutive quotes indicat ed a blank text field. These files can be easily imported into most database and spreadsheet packages. Date and time fields may require special import procedures.

CSK Files – Simulation Key Characteristics

Variable	Type	Description
DataDescriptor	integer	The digit “0”
CFES2VersionNumber	real	Version of CFES2 which wrote the record
SimKey	real	Date and time stamp of simulation execution in YYMMDD.HHMMSSSS format
FileName	string(8)	Name of CF2 file loaded prior to simulation execution
RangerUnitCode	string(3)	Code for ranger unit
SimDateTime	Date/Time	Date and time stamp of simulation execution in MM/DD/YYYY HH:MM:SS format
YearsToSimulate	integer	Number of simulated years requested by user
SimulationCode	string(27)	Code entered on Unitwide Parameters screen

CS2 FILES—SUMMARY (ANNUAL STATISTICS)

Variable	Type	Description
DataDescriptor	integer	The digit “2” if record contains annual summary for an FMAZ, “20” if record contains average for an FMAZ over the whole simulation
SimKey	real	Date and time stamp of simulation execution in YYMMDD.HHMMSSSS format
FmazCode	string(5)	FMAZ of simulated fire
SimulationYear	integer	Simulation year summarized by record (beginning with year 1) if FMAZANN data; Number of years in simulation if FMAZAVG data
FDLSummaryLevel	integer	1=Low, 2=Medium, 3=High, 4=Total for all FDL
AreaBurned	array[1..5] of real	Area burned by contained fires for size classes 1-5 for FDLSummaryLevel
AvgFireSize	real	Average acres burned per fire for FDLSummaryLevel
AreaBurnedTot	real	Total area burned by contained fires for FDLSummaryLevel
NumContainedFires	array [1..5] of integer	Number of contained fires for size classes 1-5 for FDLSummaryLevel
NumESLs	integer	Number of ESL fires for FDLSummaryLevel
NumTot	integer	Number of contained and ESL fires for FDLSummaryLevel

CS3 FILES — EVENT LIST

Variable	Type	Description
DataDescriptor	Integer	The digit "3"
SimKey	real	Date and time stamp of simulation execution in YYMMDD.HHMMSSSS format
FmazCode	string(5)	FMAZ of simulated fire
RflNum	integer	RFL # of simulated fire
IgnitionKey	Date/Time	Date and time stamp of fire ignition
FDL	integer	Fire dispatch level (1=low, 2=medium, 3=high)
Season	integer	Season of the year (1=low, 2=transition, 3=high)
Ros	real	Rate of Spread
LWratio	real	Length-to-width ratio
Tactic	string(1)	Tactic used on fire: H=Head, D=Direct-Tail, P=Parallel-Tail
MasterDispListLength	integer	Number of resources available to fight this fire
SelectedResources	integer	Number of resources selected for dispatch
Area	real	area of contained fire
Containment time	real	Minutes required to contain fire
Contained	boolean	1 if contained, 0 if ESL
Fought	boolean	1 if fire fought, 0 if no resources to send
TacticsModified	boolean	1 if simulation re-run with conservative (i.e, tail attack) tactics after initial ESL result
Cost	real	Sum of mission and per acre suppression costs

CS4 FILES — DISPATCH

Variable	Type	Description
DataDescriptor	integer	The digit “4”
SimKey	real	Date and time stamp of simulation execution in YYMMDD.HHMMSSSS format
FmazCode	string(5)	FMAZ of simulated fire
RflNum	integer	RFL # of simulated fire
IgnitionKey	Date/Time	Date and time stamp of fire ignition
ResourceID	string(8)	Resource identifier
ResponseTime	integer	Minutes required for resource to reach fire
ReturnInterval	integer	Minutes to refill/reload and return to fire
AlreadyCommitted	boolean	1=resource unavailable because already committed to another incident
Down	boolean	1=resource unavailable because of maintenance or scheduled down time
Selected	boolean	1=resource selected for potential dispatch to this incident
Used	boolean	1=resource dispatched to this incident
CommittedAsBackup	boolean	1=resource serving in backup capacity (though productivity may still count, depending on specification of the backup relationship)
ZeroedProdAsBu	boolean	1=resource assigned zero productivity because serving as backup
BackedUp	boolean	1=this resource was backed up by another resource
ProtectingStructures	boolean	1=this resource was assigned to structure protection (and thus not counted as productive for building containment line)
ProdRateAssigned	boolean	1=a rate was selected for this resource/incident
ProdRate	real	Selected rate (ch/hr) for this resource & incident
DropTime	integer	Number of minutes after which productivity changes
PostDropProdRateAdj	real	Adjustment to assigned production rate that occurs at DropTime

Appendix III: Controlling the DOS extender

This appendix contains arcane technical details unlikely to be of interest unless you are having difficulties loading CFES2 or running other applications alongside it in a multi-tasking environment. Because CFES2 is compiled to run in so-called protected mode, it can only be run on an Intel (or equivalent) 286-class computer or better. Extended mode operation provides access to as much as 64 megabytes of extended (not expanded) memory. This choice of program architecture effectively removes any limits on program capacity other than the physical amount of RAM installed in your computer. For example, on a computer with 16 megabytes of RAM, it is possible to have as many as 31,000 records (describing FMAZs, RFLs, Resources, Behavior, etc.) active in memory, thereby enabling simulations for large regions.

Protected mode requires the use of a protected mode Run-Time Manager (included on the CFES2 distribution disk as RTM.EXE) and a DOS Protected Mode Interface (DPMI16BI.OVL). CFES2 will not execute unless these two files exist in a directory that is on the DOS path or in the cfes2 directory.

By default, CFES2 will use all available memory in your machine, but use of system memory can be controlled. When a DOS protected-mode application is executed in a Windows enhanced-mode DOS box, you can control how much extended memory the run-time manager allocates by setting an XMS (eXtended Memory Specification) limit in the application's PIF file. From DOS, this can be accomplished via one of the SET RTM commands outlined below in the Borland guide to running protected mode applications.

BORLAND GUIDE TO RUNNING PROTECTED MODE APPLICATIONS (ABRIDGED)

Running a DOS Protected-Mode Application

The Borland license permits programmers using Borland Pascal to distribute DPMI16BI.OVL and RTM.EXE along with your Borland Pascal applications like CFES2.

When running a DOS protected-mode application, you must ensure that DPMI16BI.OVL (the DPMI server) and RTM.EXE (the run-time manager) are present in the current directory or on the DOS path.

A DOS protected-mode EXE file uses the same executable file format as Windows 3.x and OS/2 1.x. The file format is a superset of the normal DOS EXE format and consists of a regular EXE file image, called the stub, followed by an extended header and the protected-mode code, data, and resources. The flow of events upon executing a DOS protected-mode application is as follows:

1. DOS loads the real-mode stub and passes control to it.
2. If no DPMI services are present, the stub loads the Borland DPMI server from the DPM116BI.OVL file. Some newer 386-memory managers support DPMI services, as

does a Windows 3.x enhanced-mode DOS box. In such configurations, the stub doesn't load the DPMI server, but uses the one that is already present.

3. Next, if the run-time manager isn't already loaded in memory, the stub loads it from the RTM.EXE file. If a protected-mode application executes another protected-mode application, both use the same copy of the run-time manager.
4. Once DPMI services and the run-time manager are present, the stub switches from real to protected mode and passes control to the extended EXE loader in the run-time manager.
5. The loader first loads the DLLs used by the application (if any), and then loads the application's code and data segments. Finally, the loader passes control to the application's entry point.

When you run your DOS protected-mode program, it's always possible that a non-Borland DPMI server is already present. Because there might be slight differences among servers, especially in their handling of DOS interrupts, Borland recommends testing protected mode programs to be sure that they run with all the possible servers that they might encounter. Such testing has not been conducted for CFES2; however, CFES2 does not make calls to DOS interrupts and the authors are unaware of any incompatibilities.

Controlling the Amount of Memory RTM Uses

By default, the run-time manager consumes all available memory for itself when it loads. It then allocates memory to its clients as they request it through the memory manager API routines.

In protected mode, there is no difference between conventional memory (memory below the 1MB address) and extended memory (memory above the 1-MB address); both types of memory are available to protected-mode applications. The run-time manager favors extended memory, however. Only when all extended memory has been allocated, or when an application specifically requests conventional memory does the run-time manager allocate blocks in conventional memory.

The reason the run-time manager favors extended memory is that a protected-mode application may spawn other applications using the Exec routine in the DOS unit (e.g., the CFES2 DOS shell). Spawned applications aren't necessarily protected-mode applications; therefore, they need as much conventional memory as possible. In fact, spawned protected-mode applications start up as real-mode programs and switch to protected mode only after the stub has successfully located DPMI services and the run-time manager.

The run-time manager attempts to free as much conventional memory as possible (by moving movable memory blocks into extended memory, for example) before spawning an application. No attempt is made to release extended memory, however. Therefore, if protected-mode applications that don't use the runtime manager are to be spawned, you need a way to control the run-time manager's allocation of memory.

To control how much memory the run -time manager can use, at the DOS command line, add the RTM environment variable to your system's DOS environment using:

```
SET RTM=[option nnnn]
```

In the options below, nnnn can be a decim al number or a hex number in the form of xAB54 or xab54.

Option	Description
EXTLEAVE nnnn	Always leave at least nnnn kilobytes of extended memory available. The default value is 640K.
EXTMAX nnnn	Don't allocate more than nnnn kilobytes of extended memory. The default value is 4 gigabytes. In Windows, the default value is one-half the available memory.
EXTMIN nnnn	If fewer than nnnn kilobytes are available after applying EXTMAX and EXTLEAVE limits, terminate with an Out of Memory message. The default value is zero.
REALLEAVE nnnn	Always leave at least nnnn paragraphs of real memory available. The default value is 64K or 4096 paragraphs.
REALMAX nnnn	Don't allocate more than nnnn paragraphs of real memory. The default value is 1 megabyte or 65,535 paragraphs.
REALMIN nnnn	If fewer than nnnn paragraphs are available after applying REALMAX and REALLEAVE, terminate with an Out of Memory message. The default value is zero.

For example, the following DOS command limits RTM to 2 MB of extended memory, and ensures that 128K bytes of real memory are left unallocated.

```
SET RTM=EXTMAX 2048 REALLEAVE 8192
```

Appendix IV: Troubleshooting

DIFFICULTY STARTING CFES2

If CFES2 fails to load, make sure that you are not: (1) Trying to load it on a 8088 or 8086 class computer; or (2) Trying to load it without having RTM.EXE and DPMI16BI.OVL in the DOS path or in the CFES2 directory. See Appendix III for details.

Another likely cause of run-time errors on start-up is the presence of an older version of a CFES2.PRM file. Because the structure of this file changes from one release to the next, the presence of earlier versions of the PRM file in the CFES2 startup directory can produce unrecoverable errors when the program attempts to read the file. The remedy is to rename CFES2.PRM to CFES2PRM.BAK. When CFES2 is installed via that installation program CFESINST.EXE, existing CFES2.PRM files are removed automatically. If CFES2.EXE is copied to a directory containing an outdated CFES2.PRM file without using CFESINST.EXE, that PRM file MUST be renamed or deleted in order to run CFES2.

Appendix V: Glossary of Terminology, Acronyms and Parameters

AFFIRMS	Administrative Forest Fire Information and Retrieval Management System, a nationwide network of fire weather stations linked to a computer database
BEHAVE	The fire behavior modeling component of the Fire Behavior Prediction System
BI	Burning index, a fire behavior parameter designed to represent fire intensity and which is equivalent to 10 times the predicted flame height (in feet)
C+NVC	Cost plus net value change (originally, least cost plus loss), a long standing economic criterion of fire protection efficiency
CDF	The California Department of Forestry and Fire Protection, the State agency in California responsible for fire protection in all unincorporated, wildland vegetation
CFES	The California Fire Economics Simulator, a computer program designed by the author to simulate initial attack on wildland fire; Version 1 is deterministic and based conceptually on the USFS's NFMAS model; Version 2 is a completely different, stochastic model designed to capture as much realism and natural variability as possible
Control condition	A generically describable geographic/ vegetational situation encountered by firefighters; serves as a strata for estimating fireline production rates
Direct attack	The practice of fighting a fire directly on its perimeter, i.e., "1 foot in the green and 1 in the black"
Dropoff distance	Distance after which the productivity of a line-building resource drops off from an initial value to some lower, but indefinitely sustainable level
Escape	A fire that grows to a size sufficient to require the deployment if extended (as opposed to initial) attack forces; also set as a policy variable to define maximum acceptable fire size; sometimes used synonymously with ESL
ESL	A fire that exceeds the limits of the simulator based on either time or size -- time because extended attack resources would be sent, size because elliptical model likely to break down; sometimes used synonomously with Escape

FDL	Fire dispatch level, a 3-level system of fire danger assessment intended to assist CDF ranger unit personnel in determining how many resources to dispatch when a fire occurs; can be set according to ROS, BI, time of day or any combination thereof
Fire seasons	Low, transition and high seasons are defined by natural discontinuities in the frequency of fire occurrence; they also correspond to when temporary firefighters are added to, or laid off from, the CDF forces
Fireday	A Bernoulli variable used in the fire occurence module to
Firefighting resource	Any resource, with or without a production rate, that is dispatched as a unit to fight a fire, e.g., fire engines, handcrews, bulldozers, air tankers, helicopters, air attack, water tenders, etc.
Fireline production	The act of building a line around a fire, cleared of all vegetation or wetted sufficiently to prevent combustion
FMAZ	Fire Management Analysis Zone, an area with some homogeneity of characteristics, and a fundamental unit of analysis in both CFES versions
Fuel Combination	The combination of an NFDRS fuel model with a shade factor, slope class, vegetation type, and climate class; sometimes used to refer to this plus a weather station
Fuel Model	NFDRS fuel model (A-T) plus a one digit shade factor (1-3) as implemented by CDF in their PC implementation of Behave
Head attack	When a fire is attacked at the head first (i.e., where spread is fastest
Initial attack	The first hours of a fire suppression effort, in which the goal is containment of the perimeter at the earliest possible time
Multiplicity	The number of fires that occur on a day with one or more fires
NFDRS	National Fire Danger Rating System, a USFS model of fire behavior based on 2PM weather observations and stylized fuel models
NFMAS	National Fire Management Analysis System, an initial attack simulator used by the USFS for fire protection planning and budgeting; its initial attack model, IAA (Initial Action Assessment), was the basis for CFES Version 1
Parallel attack	An attack tactic in which fireline is built a some specified distance away from the flaming front
Production Rates	The rate at which fireline can be built

Ranger unit	The basic administrative unit within the CDF, typically the size of one or more counties
RAWS	Remote Automated Weather Stations, the source of hourly weather observations used to estimate diurnal adjustment functions
Resource	see firefighting resource
RFL	Representative Fire Location
ROS	Rate of Spread, ususally in chains per hour (1 chain = 66 feet)
SCU	Abbreviation for the Santa Clara ranger unit
Tail attack	When a fire is attacked first at the tail, i.e., near its origin and where flames are spreading the slowest
Time of Day (ToD)	The time of day at which a fire occurs, usually refers to a fitted frequency distribution (beta or poisson)
USFS	United States Forest Service
Vegetation Management Program	A CDF program for executing controlled burning of flammable vegetation at times of the year when it is safe to do so, with the intent of reducing the potential for catastrophic fires

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